THE AMERICAN

JOURNAL OF PSYCHOLOGY

Founded by G. STANLEY HALL in 1887.

Vol. XI. JANUARY, 1900. No. 2.

AN EXPERIMENTAL STUDY OF THE MENTAL PROCESSES OF THE RAT.

By WILLARD S. SMALL,
Fellow in Psychology, Clark University.

The studies presented in this paper are concerned solely with the mental life of the white rat, the albino sport of the common pest, *mus decumanus*. The white rat exists, so far as I am able to learn, only in captivity, and so, though especially suited for laboratory study, may be expected to present some slight variation from its wild congeners. No apology is made, however, for this limitation, for the writer feels that at present the greatest need of Comparative Psychology is the careful description of the psychic life of special animal forms. Generalizations will come in due time.

Work of this kind has already been done by several investigators in various phases of comparative psychology, the most systematic studies of vertebrates being those of Dr. Thorndike in the Columbia laboratory, and of Dr. Kline in the Clark laboratory.[1]

The chief difficulty of such experimentation lies in controlling the conditions of the problem without interfering with the natural instincts and proclivities of the animal, and thus distracting or deflecting its attention. "An animal should be made to do difficult things only in the line of its inherent abilities."[2]

[1] Thorndike: Animal Intelligence, Psy. Rev. Monographs, No. 8. Kline: Methods in Animal Psychology, *Am. Jour. Psy.*, Vol. V, No. 2; Laboratory Course in Comp. Psy., *Am. Jour. Psy.*, Vol. V, No. 3. Morgan, Mills and others have, of course, made experiments of great value, but for the most part of a more informal character.

[2] Ernest Ingersoll: Wild Neighbors, p. 179.

The experiments described in this paper are a part of a series carried on in the Clark laboratory in the academic year 1898-99. Their primary purpose was to study the character of the associative processes of the rat; *pari passu* with which, however, would necessarily go a study of the general character of its intelligence as conditioned by its dominant instincts, structural and functional traits, affective life, etc., as well as by the form of the associative processes—indeed as basal to them. The word association is used broadly to cover all possible connections of mental elements as indicated by the activities of the animals. Wundt's definition of association as "ideational connections which do not exhibit the characteristics of the activity of logical thought" might serve in this case with the more general phrase "connections of mental elements" substituted for "ideational connections." Wundt's definition is useful as a description of the upper limits of association.

The experiments described fall into six groups. All of them bear upon the problem of the manner in which contiguous associations originate and are integrated; upon the persistence of such processes; and the factors entering into them. Other points studied are variability of the association after it is formed, recognition and discrimination, imitation, and individual differences.

The diary, extracts from which are contained in the following pages, was made while the observations were in progress, and so records the impressions while they were "hot." Interpretative conclusions, tentative in most cases, are advanced here and there. This method of presentation is believed to be the most fruitful under the circumstances.

GROUP I. This group of experiments was the original point of departure for all the succeeding experimentation. It was undertaken merely as a study in method in comparative psychology for the laboratory, based upon the general principles of such study as enunciated in the introductory section. The most definite point in view was to test the rat's peculiar modes of activity in the process of forming definite associations within the scope of its natural mental experience; the rapidity with which such formations are perfected; their stability and permanence, and, in general, to get a more accurate knowledge of the kind of intelligence possessed by the rat. It will be seen, then, that the aim was comparative in the exact sense, as well as structural. Indeed the structural aim was subsidiary.

The most natural motive to play upon in such experimentation is hunger. This furnishes the best dynamic for mental procedure. The rat is no exception to the reign of the nutritive impulse.[1] On the active side digging was selected as a

[1] I trust the reader will not "jump" to the conclusion that no other

characteristic instinctive activity in the free life of the rat—as was clearly apparent in the writer's Study of Psychic Development.[1]

The apparatus used was a cubical box of 6-inch dimensions. The sides were of ¼-inch wire mesh; the bottom of wood ⅞-inch thich; and the top of glass. In the front side of the bottom was a hole large enough to admit a rat. The bottom was raised 1½ inches from the floor of the cage by strips of wood on the sides of the bottom. In experimentation the food was put inside the box, and sawdust was banked around the box to the top of the floor, completely concealing the entrance. This will be spoken of as Box I; two series of experiments were made with it upon two pairs of rats. The experiments were performed in the cages[2] where the rats were usually kept. At the regular time for feeding, Box I, containing food, was placed in the cage and banked up with sawdust. Before the experiments were begun Box I was left open in the cage for several days that the rats might become perfectly familiar with its appearance. Their timidity makes such precaution advisable.

Series I. Rats I and II (both females). The series consisted of 13 experiments, on successive days. The selected examples[3] which follow show the results of the series. The notes were made always while watching the experiments.

Experiment 1. Both rats attacked the box at once. They crawled all over the box, and went round and round it monotonously. Sniffed continually. After an hour of persevering effort they began to get discouraged; their movements becoming haphazard and indifferent. One gave up and returned to the nest. The other, more frisky, soon began scratching about instinctively. The hole thus accidentally dug happened to be in the right place. The rat immediately poked its nose into the new opening which was not large enough to admit its head. It then ran away as if frightened, but soon returned, sniffed cautiously at the hole, dug away more sawdust, and then scampered away again. These acts were repeated several times, till a large opening was made. The rat then entered cautiously, snatched a piece of food and carried it into its hiding place in the corner of the cage. Time, 1 hr. 30 m.

---

motive would be workable. Hunger is merely the most fundamental and most surely-to-be-relied upon.

[1] *American Journal of Psychology*, XI, 1899, 80-100.

[2] Cage as follows: Dimensions in inches. Length, 20; height, 16; width, 16. Floor, back, and top of wood; front and one end of glass; other end, wire mesh (¼-in.) for ventilation. Floor is covered with sawdust.

[3] A detailed account of the first five of this series may be found in Kline's article: Methods in Animal Psychology, *Amer. Jour. of Psy.*, Vol. X, No. 2, p. 277. I quote in part from that account.

Experiment 2. Actions similar to those of the preceding day, except that they spent more time near the place excavated yesterday, seeming to have located the right place indefinitely. After four minutes of frisking and fidgeting one began digging with a will, not stopping till the work was completed. As before, they did not enter at once, but frisked about nervously —peering into the hole, scuttling away and sniffing for some minutes. Time, 8 m.

Experiment 3. Rats began work immediately, and confined their efforts to movements about the right place. Sniffed around for a minute and a half, then one began to dig, and completed the task in one-half minute. No hesitation about entering. Time, 2½ m.

Experiment 5. Only one rat came out. Approached the box leisurely, sniffing the air as she went. Stood erect, with forepaws against the box. Suddenly dropped down and began digging. When half done, stopped, walked away, returned and finished the work. Entered and took food. Time, 3½ m.

Experiment 13. Most of the useless movements have been dropped. There seems to be a pretty definite idea of what is to be done. Time, 30 sec.

The features of the series were the rapid reduction of the time required to get into the box, the elimination of most of the useless preliminary movements, and the apparent definiteness of the movements at the end of the series. The time required was reduced from 1 hr. and 30 m. the first day, to 8 m. the second day, and so on gradually to 30 sec. the last day. At the fifth trial, however, the associative process seemed very insecure. The rats had not learned to dig at exactly the right place, nor did they dig at all till they had examined the box several times; but at the end of the series they had definitely located the point of attack, and associated that with the appropriate movements, so that if *very hungry* they would begin immediately to dig in that spot. The nervousness relative to entering the box after the excavation had been made, so apparent the first few days, disappeared entirely about the sixth day. The actual time relations of the series are given in Table I.[1] It will appear from this table and from other tables that the time relation will not serve as an exact index of the definiteness and certainty of the mental process thus figured.[2] It does give, however, a general index, if the relation considered be that of one experiment to the whole series, not to the next consecutive experiment.

Series II. Rats III and IV. The conditions and apparatus were exactly as in Series I. Both rats were females.

[1] See tables at the end of the article.

[2] For this reason I have not plotted any time curves.

Experiment 1. The rats worked at intervals for 35 m., when they got the food. They dug very little at a time. At no time did they become aware that the sawdust was the obstructing object. They were not quite so vigorous in their efforts as I and II had been.

Experiment 2. They dug in in two and a half minutes.

Experiment 3. After the usual preliminary sniffing they dug in. The movements were not very vigorous, and they did not confine their efforts to the objective point. Rather, they dug promiscuously along the whole side of the box, showing that the place of entrance is not located.

Experiment 4. Secured the food in one minute.

Experiment 6. One rat went at once to the right spot and dug four or five strokes. Tried then to enter, but stuck half way. Withdrew head and finished the excavation in a most business-like way. Time, 30 sec. The other rat did no digging, but tried to steal her industrious comrade's hard-earned food. Failing in this she came to the hole, but did not enter. Ran back and again tried to steal, evidently not realizing at all the significance of the hole—or perhaps a safer suggestion would be that the certainty of the piece in the other rat's possession distracted her from making exploration. After about 1½ m. scuffling she came again to the box and got the remaining piece of bread.

Experiment 8. Did not begin work for nearly a minute. Then went directly to the right place. The sawdust was piled a little higher than usual. The "leading" rat went once around the box, as if looking for an easier place. Came back and dug in. Actual time, ½ m. The other rat tried, for several minutes, to steal her mate's food before going to the box.

Experiment 9. Delay of ten minutes before leaving the nest. Then dug in in a few seconds.

Experiment 10. Both rats very hungry. Hardly waited for me to close the box; sniffed and tried to get in while I was banking the sawdust. Into the box with a few strokes. Time, 10 sec. The second rat is not so sharp. First tried to steal the bread from her mate; then poked her head into the hole, but did not find the bread, as it was in the opposite corner. She then alternated for some minutes between fighting with her mate, and digging at the corner inside of which was the other piece of bread. This suggests that this rat does not associate the *whole of the box* with the food. It may be that the association in the case of the other rat is between *digging at a special place* and getting the food, the visual image of the box as a whole having a very unimportant rôle in the process. The second rat finally got the food from her mate. This one returned at once to the box and got the other piece.

Experiment 13. The "leading" rat instantly attacked the right place, and dug in with a few well directed strokes. Not a false or unnecessary movement. Time, 10 sec. The other rat stole her mate's bread. The latter returned immediately and got the second piece.[1]

Experiment 18. Neither rat attempted to get the food. They walked idly around the box once or twice, then went to their nest and lay down.

Experiment 19. Rat III went immediately to work—apparently very hungry. She dug half-way in, and then paused and ran around to the side of the box, as if to see whether the food were there. Back, and in. Sniffed both pieces of bread; took the larger.

Examination and comparison of these two series of experiments, made under conditions as nearly identical as possible, yield some interesting results. (a) It was not remarked in the course of Series I, that only one of the rats had learned to perform the task. This was observed in the course of Series II, and proven after experiment 13. There is no doubt, however, that the same is true of the rats in Series I, as was confirmed later. The significant thing about this fact is the reflection it casts upon the imitative faculty of the rat. Rat IV must have seen Rat III make the excavation and enter for the food, but she did not imitate the action. The action and the end were not inferentially associated. This fact limits, but does not exclude imitation. (b) The time factor in the two series shows marked differences. Under identical conditions the rats in Series I required for experiment 1 more than double the time required by those in Series II—90 and 35 m., respectively; and a similar difference appears in following down the table, noting the relative celerity with which the association becomes definite and stable: in Series I the minimum time is 20 sec., reached in experiment 13; in Series II the minimum is 10 sec., reached in experiment 10, the minimum of Series I, 30 sec., being reached in Series II in experiment 6. (c) The immense importance of the first success is brought into relief by the drop in time from the first to the second experiment in both series, 90 m. to 8 m., and 35 m. to 2½ m., respectively. (d) The irregularity of the time factor after the rats had learned the task is noteworthy. In Series II, *e. g.*, the variation is from 10 sec. to 40 sec. after experiment 9, when the task was fully mastered. This variation is due to several causes, probably, the

[1] Being pretty well convinced that the same rat was doing the work each time, I now marked the rats so that they were easily distinguishable. I designate them hereafter III and IV, III being the one that had solved the problem.

most apparent of which are variations in appetite, and the normal "flightiness" and timidity of the rat.

GROUP II. In purpose and execution this group of experiments coincides with Group I. As, in that case, the end aimed at was a carefully controlled observation of the *modus operandi* of the rats in solving a problem easily within their capacity, and without inhibiting or distracting influences. The difference lies in the instinctive activity appealed to, gnawing instead of digging, and the adaptation of apparatus to that activity. There is also a further slight difference in the conditions, in the substitution of the new piece of apparatus, similar in appearance to that with which they were already familiar. This tests incidentally their power of recognition and discrimination—the same rats being used.

The apparatus used in this group, and designated Box II, was as follows: Form, material and dimensions, the same as Box I. The only difference is that the entrance is a small opening, two and one-half inches square, on one side. This opening is provided with an inward swinging door of sheet zinc swung from the top. The door and the top of the cage are connected by a strong rubber band, so that the door, when free, is held open. The door is closed securely by means of narrow strips of stout paper stuck, with sealing-wax, to the door and the lower edge of the box. Admission to the box can only be had by removing the obstructing papers.[1] This might be effected in several ways, by scratching, biting, or pulling the paper off, or even by butting the door in with the nose. It was expected, however, that biting or gnawing would be resorted to in most cases, as this would be the easiest method.

Series I. Rats I and II. Previous to the experimentation recorded in Series I of Group I a few tentative tests had been made with Box II upon a pair of rats; one of which was *Rat I or II* of the later experiments. The results of this experimentation were so unsatisfactory that the method was abandoned temporarily.[2] This was eighteen days before the beginning of this series. A brief résumé of these abortive experiments and suggestions as to the reason of their failure is given in the foot note below.[3] They have a positive value in showing how im-

[1] This box was also described in the *Am. Jour. of Psy.*, Vol. X, 1899, p. 426.

[2] *Am. Jour. of Psy., loc. cit.*

[3] For several days before the experiments were begun, Box II had been left in the cage with the rats. The door was left open so that the rats might become fully acquainted with the apparatus, thus eliminating the element of unfamiliarity. The first experiment was tried at 9 A. M. After nine minutes of running about and climbing over the box, one of the rats suddenly seized the paper and tore it loose (one strip only was used). The noise of the door springing open frightened the rats

portant it is to conform to the character of the animal studied. This previous experience of one of the rats in this series possibly accounts for the apparent superiority of the rats used in this series over those used in Series II of this group.

Experiment 1. After the usual reconnoissance the rats pawed away the small amount of sawdust that chanced to be around the bottom of the box; then pulled off one of the strips of paper. The other strip, being attached loosely, permitted the door to swing inward about half an inch. The rats attempted to squeeze their heads in, and thus forced the door open. Time, 10 m.

Experiment 2. Got the door open in 14 m. They appeared to give up after working a few minutes, but soon returned with renewed vigor.

Experiment 3. The rats have located the obstacle, and confine their operations to the immediate vicinity of the metal door —pushing it with nose, *clawing* at the papers—not gnawing— and occasionally digging away the sawdust. Finally *clawed* the paper off. Time, 3 m.

Experiment 4. *Clawed* the paper off. Time, 2 m.

Experiment 5. They spent much time digging the sawdust away from the front of the door. They seem not to have learned

---

away, but after a short hesitation they entered and secured the food. Time, 10 m. Experiment 2 was made 25 m. later. (The food was taken away—only a crumb being allowed as a "reward of merit.") After 20 m. of investigation the rats gave up the task and lay down in their nest. The box was removed. Experiment 3 was tried at 3.50 P. M. the same day. The spring was thrown after 45 m.; but this was accomplished by casually butting the head against the door. For 12 m. after the door was open their timidity prevented them from entering the box. They then snatched the food and ran out as if in great terror. On the following day four more experiments were made. The time was reduced to 3 m. in three experiments. The place was located, but the paper was not identified as the obstructing object. After experiments 4, 5 and 6, the food was taken away. In the 7th experiment the rat that had done all the work before seemed stolid and refused to work. The other rat accomplished nothing. The former died the same day. This apparatus was then given up, and Box I was tried.

These experiments were not a total failure, though the number was insufficient for the attainment of definite results. But their value would have been vitiated even if the rat had lived and they could have been carried further, for the method was very crudely applied. (a) The most opportune time for experimentation with rats is their time of greatest activity—late in the afternoon. They normally sleep all day. Their activity in the morning was purely factitious, due to extreme hunger. (b) The quick succession of experiments, followed in each case by deprivation of the fruits of their labor, was bad method. Nothing could be worse pedagogically, at least from a human standpoint. To establish an association train of which the motive and first term is hunger, and the end and last term is satisfaction of hunger, the train ought to be fully realized each time. The success of the later experiments, under the same conditions, established the validity of these corrections.

yet that the strips of paper are the real obstacles. They claw at the papers in a haphazard way—a sort of general scramble about the door. Nothing definite is yet expressed in their movements. Time, 3 m.

Experiment 6. Tore open the door, using both teeth and claws, in 1½ m.

Experiment 7. Tore open the door in 2 m. A few minutes later one of the rats went carefully sniffing around the outside of the box. She then entered and examined the inside, sniffing and pawing curiously. After coming out she dug the sawdust from under the edge of the box near the door. These actions illustrate the rat's method of getting thoroughly acquainted with his surroundings. The prominence of the olfactory and the motor elements are striking. The digging suggests that this box is not yet discriminated from Box I.

Experiment 8. The rats ran around and over the box a few times, and then dug a few strokes in front of the door. Then one of the rats, seizing one of the paper strips firmly in her jaws, tore away the upper half. Ran away as if frightened by her success. Soon returned and tore off the *other half.* She then seized the other piece and jerked that off. Entered immediately, got food, and came out to eat. It was a definite, business-like proceeding. Time, 3 m.

Experiment 9. Time, 1 m. Ran once around the box; then stopped in front of the door and dug away the sawdust. *Clawed* at the paper, using the teeth only as accessory. It is pretty clear that they use their teeth only as a last resort. N. B. They had not eaten last night's supper, yet they worked just as though they were hungry. This suggests at once the complexity of the problem we are dealing with. The action of the rats in this case is probably an outcrop of the primitive hoarding or property instinct. This is exceedingly strong in rats. An admirable illustration of the point is furnished by a female rat, with young, who made twenty-five journeys from and to her cage, carrying food;[1] and, in general, both male and female show a well-marked tendency to provide against a rainy day. Incidentally this is eloquent testimony to the persistence of "wild traits in tame animals,"[2] for these rats are practically strangers

[1] This was a rat whose litter of young was under observation. As she was quite tame her cage was often left open, so that she could roam over the table upon which stood several cages. On one occasion several small piles of dog-bread (small pieces) had been left about the table. Soon after coming out of the cage she discovered one of the piles, and proceeded to carry all of the bread to her cage. Then she continued her quest, and did not stop till she had secured every pile, making twenty-five journeys. This, in the face of the fact that she was always well-fed and had food in her cage at the time.

[2] *Cf.* Dr. Louis Robinson's book, Wild Traits in Tame Animals. London, 1897.

to hunger. The puzzling side of the matter comes into relief when we remember that oftentimes the rats, when not hungry, are quite indifferent to the presence of the box containing the food. These vacillations of conduct are explicable only upon the basis of radical fluctuations in the organic tone of the animal, something akin to the fluctuations in the human organism, as, *e. g.*, when the normal acquisitive impulse is inhibited by the feeling of indolent ease.

Experiment 10. One rat did all the work. The other entered immediately after the first one was out. The successful rat dug away the sawdust from before the door, and took hold of one of the papers which projected slightly below the bottom edge of the box. This act throws light upon the remarkable persistence of the useless digging movements. The projecting papers are brought into view by the digging away of the sawdust, and are bitten at quite naturally. The digging seems useful to the rat. The second piece she quickly tore off, seizing it firmly in her jaws about midway. Time, 30 sec.[1]

Experiment 11. Rat I ran once around the box, paused in front of the door and dug two strokes; then tore off the strips of paper in quick succession, seizing each strip firmly in the middle. No clawing or useless biting at the papers. The rapidly perfecting definiteness of this reaction is apparent by reference to the remark in experiment 9, apropos of the use of the teeth. Time, 30 sec.

Experiment 12. Rat II ran once around the box, dug away the sawdust from the door, and then poked the door open with her nose. Rat I remained in the nest. Three methods of opening the door have now been employed successfully: clawing, biting, and butting with the nose. Biting, as the most rapid and effective, seems to have been adopted finally by Rat I. Time, 30 sec.

Experiment 13. Rat I, after two strokes of digging, tore off the papers with her teeth. Time, 15 sec. In the course of these thirteen experiments Rat I has definitely located the obstruction (this was clear at the eleventh trial), and has eliminated all the useless preliminary movements except a mere vestige of digging. The time is reduced from 10 m. to 30 sec.

Experiment 16. Time, 20 sec. Rat I was evidently very hungry—so hungry as to fall into the error of digging violently. She stopped suddenly after a few seconds and made a savage attack on the papers. The action suggested that the hunger feeling was so strong as to start off automatically the digging reflex, which was inhibited suddenly by the memory

[1] It was at this point that these two rats were first marked, for the same reason as III and IV. They are designated I and II hereafter.

of the right action. The occasion of the resurgence of this memory may have been either the sight of the door and papers, or the rising of the impulse to bite the papers, this action having followed the digging each time in the process of getting the food. Under stress of hunger, attention was directed away from means to the end. Consequently, instead of a minimizing of useless movements, there was freedom accorded to the automatic movements.[1]

Series II. Rats III and IV. This series followed immediately Series II of Group I. The rats had had no experience with this apparatus. This series, therefore, is more typical of the rat's attitude toward this task (Box II) than is Series I. Reference to Table II will show this numerically.

Experiment 1. No results at the end of 30 m. The rats clearly recognized a different apparatus. They did not dig at the accustomed place, but ran around and over the box sniffing curiously. The movements were deliberate and seemed impelled as much by curiosity as by hunger. Occasionally they sniffed at the food which lay against the back side of the box—away from the door; and made one or two desultory strokes in the sawdust at that point, but showed little interest. They also nosed the papers a few times but made no attempt to bite or claw them or to butt the door. At no time did they dig in front of the door. The absence of this movement is striking, in view of its chronic persistence with Rats I and II. The box was removed at the end of half an hour. The rats were not fed.

The two interesting features of this experiment are the recognition of a different box and the non-persistence of the digging habit. One cannot but ask whether the digging impulse in this case is inhibited by the recognition of a different task—a recognition which was not at all apparent in the case of Rats I and II.

Experiment 2. Rats very hungry. At the end of 45 m. they had made no progress. Once or twice they sniffed at the door—the contrast between the solid metal of the door and the wire mesh of the rest of the box doubtless exciting attention—but showed clearly that they had no suspicion of its use. They dug all the sawdust away from the back corner where the food was, and spent most of the time savagely biting and pulling at the meshes. At the end of 45 m. the food was moved over near the door. The rats continued to bite stupidly at the wires. Box

[1] The next experiment gave striking confirmation of this view. Rat I was so hungry as to try to get at the box before I removed my hand. In her excitement she gave way to several of the useless preliminary movements that had been sloughed off. Time, 35 sec. In experiment 18 she appeared less excited, discarded nearly all the useless movements, and did the work in 10 sec. Similarly in experiment 19.

was removed at the end of one hour. It is possible that their extreme stupidity may have been due to hunger—they had had nothing but a little milk for 48 hours—as is suggested in the case of the recrudescence of useless movements in experiment 16 of Series I. Curiosity, which might lead them ordinarily to attack the papers, is choked by hunger, so that they blindly follow their noses, attacking the wires nearest the food. There was also a noticeable heightening of suggestibility, each rat feverishly doing what the other did—as if afraid the other would gain some advantage.

Experiments 3 and 4. In the third experiment the rats made no progress in 30 m. (No food had been given them except a little milk.) The box was left in the cage. During the night they removed one of the paper strips, but did not attack the other. The inference seems clear that the rats did not see the point. They would have gnawed papers from the broad side of the cage just as readily. The box was removed the next morning. A fourth trial was made in the afternoon—at the usual hour. At the end of 30 m. they had accomplished nothing and appeared to be utterly discouraged. I rubbed a drop of milk on one of the papers, thinking that it might suggest the appropriate action; but they merely lapped the milk off, and did not bite the paper at all. The box was again left in the cage. During the night they succeeded in solving the problem. They had gnawed the paper off neatly, leaving but a bit at the top of the door.

Throughout these four experiments, the persistence and the stupidity of the rats were equally surprising. Stupidity is not quite an exact term, for the rats in confining their efforts, as they did generally, to the vicinity of the food, were simply acting according to their usual habit of gnawing to food by the shortest way. The fact that they finally attacked the door implies that they came to have some kind of an idea of the box as a whole being the obstruction, for the food was somewhat removed from the door. The act would seem to involve a low order of judgment.

Experiment 5. Time, 3 m. Ran a few times around and over the box, but constantly came back to the door. It was apparent that the door suggested pleasant associations. Rat III then dug a little sawdust from before the door; ran away; returned and dug some more. She then paused, sniffed at the paper meditatively; suddenly bit one strip off very neatly. Startled by her success, she skipped away; but soon returned, sniffed the second strip, and quickly tore that off. She recoiled some inches at the springing of the door, but soon entered. This was the cleanest piece of work performed by any rat up to this time. The rat seemed to have the elements of the asso-

ciation chain well in mind. The co-ordination of the elements, however, was not immediate, as the hesitation at critical points shows. A stronger concentration of attention was shown here than was shown by Rats I and II at any time in Series I. The rapid integration of the association elements suggests either a higher degree of intelligence or a more powerful affective impression consequent upon the previous success after several days of failure and hunger.[1]

Experiment 7. Rat IV threw the spring by butting her nose against the door. Purely accidental; the papers adhering too loosely. The rat was surprised. Time, 1 m.

Experiment 8. The papers were cut in 4½ m. The rats seemed to know the obstruction but "put off" attacking it. The next experiment gave similar results. Time, 5 m. They walked leisurely around and over the box as if saying: "We can get in when we want to." The work was clean and sure when they got ready to do it.

Experiments 10–12. Experiment 10. The rats promptly attacked the task and quickly performed it. Rat III. No false movements. Time, 15 sec. Experiment 11 showed striking variations. Rat III went to work at once. She approached and sniffed at the door three times before touching the papers. Finally she poked the door with her nose; then braced her fore-paw against it and pulled the paper with her teeth. As it did not yield she ran away. Soon returned and got off one strip. Then she dug in a casual way at the corner near the bread. Finally came back and pulled off the other strip. Time, 1 m. She did not seem at all sure of her procedure. On the following day, she finished the task in 50 sec. Her movements were leisurely but as definite as could be desired; not a false movement was made.

The results of this group of experiments confirm those of the first group. (a) There is the same lack of initiative on the part of two of the rats. In both series of both groups one of the rats, by superior intelligence or activity, first solved the problem; afterwards these rats continued each day to open the door, the other rats complacently falling into the habit of entering the box, after the door had been opened, and getting the food, or of stealing the food from their successful companion. There was in the case of these inactive or unintelligent rats a manifest decrease of interest and effort in getting the box open between the first and the last experiment. On several occasions they did not leave the nest till their companions had opened the door. It is to be observed, also, that it was Rat III that did all the work in Series II of Group I. As Rats I and II were not marked

[1] The following day the time was reduced to 2 m.

in their series under Group I, one cannot be absolutely certain that Rat I did all the work; but the results of their series in Group II, and of the experiments with Rats III and IV in both groups leave little room for doubt. (b) The fluctuations in the time factor again come into prominence. Both series in this group exhibit these irregularities; but they appear more markedly in the second. In this series the required time falls from several hours to 1 minute, rises to 5 minutes, and falls again to 15 seconds within a period of 7 days. (c) The importance of the first success is also emphasized again in the second series of this group. This was evidenced not less by the definiteness of movement in the fifth experiment than by the decrease in time.

Some new points are brought out in this group. (a) The persistence of useless motor habits is striking. This was remarked in passing. The persistence of the digging habit was especially noticeable. This appeared prominently when the rats were unusually hungry or excited. Individual variations are apparent again in this respect; the tendency to dig is decidedly less marked in Series II than in Series I. The persistency of these motor habits is explainable by the supposition that the movements are touched off automatically: *e. g.*, the digging, by the sight of the box, the rat not yet discriminating the boxes. The action illustrates the thoroughly automatic character of motor memory. (b) The form the association takes seems largely fortuitous. The method the rat finally follows depends upon what action is accidentally successful the first time. If a rat happens to succeed by several methods, as, *e. g.*, biting, clawing, butting, there is a strongly marked tendency to select the most expeditious and effective method. This apparent selection, however, is rather a matter of inertia than of prevision. In general, it is safe to say the animal chances to hit upon the easiest method. (c) It can hardly be doubted that the affective tone of the animal organism conditions the associative processes. Slight variations in organic tone may throw the whole associative formation out of gear. This fact makes the estimation of the mental elements and values involved a difficult matter. Only proximate explanations are to be expected.

GROUP III. This group of experiments immediately followed Group II. The object was to test the rat's power of discrimination. The question arose, of course, in connection with Group II, in which a second apparatus, very like the first in appearance, was used. Both series seemed to indicate that the rats recognized a different apparatus, though the demonstration was clearer in the second than in the first series. In the first case the recognition of the new did not make sufficient impression to inhibit the almost automatic return to the old

method of entering the box by digging; but in the second series that method was not employed. But this experiment showed nothing of the real character of the discriminative process. In order to test more fully its character—its quickness and keenness, its permanence, and, if possible, its elementary character, this third group of experiments was made. Incidentally light is also thrown upon recognition and memory. In this third group the two boxes were used alternately, at unequal intervals, with the two pairs of rats. As the rats were now acquainted with both boxes, the quickness, certainty and appropriateness of reaction in the presence of each box would serve as a rough measure of the discrimination, allowance being made for fluctuations of interest under varying affective conditions. Twenty-five tests were made with each pair of rats, a summary of which follows. The order of alternation and the time results are given in Table III.

Series I. Rats I and II. This series was made immediately after a second trial with Box I.[1] They had not seen Box II for 12 days.

Experiment 1. Box II. Time, 1 m. Rat I was eager and hardly waited for the apparatus to be put into the cage. She sniffed at the door, climbed upon the box, came back to the door, dug a few strokes, poked the door with her nose in a tentative manner; finally she seized the papers (getting hold of both pieces) and tore them off. The actions were methodical and deliberate. The discrimination was not immediate, but seemed definite when arrived at. In the second experiment Rat I bit off one paper and then butted the door in with her nose. Time, 30 sec.

Experiment 3. Box I. Time, 1½ m. Rat I played around and over the box more than a minute. Finally, she went and smelled of the food which lay against the back side of the box; then came to the right spot and dug in. The action was perfectly definite *when she got ready to do it.*

Experiment 4. Box II. Time, 1⅓ m. Rat I spent half a minute climbing over the box. She then came to the door, pulled off one paper, and then tried to poke open the door with her nose. Failing in this, she dug all the sawdust away from the front of the box; then ran away; came back and pulled off the second paper. The movements in this experiment indicate that the rat is still in the "trial and error" stage. One would infer that she neither discriminates the boxes, nor knows what action is most efficacious after she has discovered

[1] These experiments gave no results other than imperfect recognition of Box I, after the series with Box II. The average time was longer than in Series I of Group I after the first.

which box she is dealing with. The contrast is marked between her recognition of Box I in experiment 3 and her confusion in this experiment. The repetition, too, of the procedure employed successfully in experiment 2 is worthy of note, especially as its failure in this case was followed by a lapse into complete incertitude as indicated by the digging. The three succeeding experiments with the same box gave practically the same result, confirming the judgment expressed above.

Experiment 7 (same box), shows some improvement. Time, 50 sec. Rat I dug completely under the box; then changed tactics and bit off the two strips of paper in rapid succession. Between the two acts there was a slight pause, the rat giving one the impression of thoughtfully considering and concluding: "I dig under and don't find the entrance; therefore, I 'll bite these papers." If the reader will divest this process of its conceptual character and endow it only with the character of a conflict or succession of motor impulses conserved as memory and rising spontaneously at the sight of the box, he probably will not be far from right. The pause may be interpreted as the interval between the recognition of the failure of the first effort and the rising of the second and appropriate memory-image.

Experiment 8. Box I. Time, 30 sec. The movements were clean and rapid. It is not clear to me whether Rat I really *recognizes* this box or whether she digs automatically at the sight of any box, and so accidentally gives the appearance of recognizing. The facts noted in the preceding paragraph lend color to this interpretation. On the other hand, there seems to be more sureness and confidence in her attacks upon this box, a fact which looks toward actual recognition.

Experiments 9 to 14 inclusive were with Box II again. In the 9th and 10th the rats were either indisposed or not hungry. They were indifferent to the box, which was removed after 5 m. In experiment 11, Rat I ran slowly around and over the box, languidly dug the sawdust from before the door, and finally pulled off the papers by grasping them below the lower edge of the bottom of the box—a stupid and laborious performance. Time, 1 m. 10 sec. In experiment 13, after "fooling" for nearly a minute, Rat I did the work with expedition and certainty. Her actions suggested a small boy looking for an easy method of doing a thing.

Experiment 15. Box I. Time, 10 sec. Rat I. No false movements. Experiments 16 and 17 gave results similar in definitiveness and precision.

The final eight experiments, 18 to 25 inclusive, were made with Box II. These show the same fluctuations as noted in all preceding experiments, both in this group and other groups.

In experiment 18, Rat I, after "fooling" for nearly 40 sec., did the actual work in about 5 sec. In experiment 19, she succeeded in butting the door open with her nose. The next day she performed the task—biting off the papers—with few false movements, but it was by no means apparent that she realized that the paper was the obstructing factor. At the end of the series the matter was still in doubt, for in the last experiment, the door was butted open.

The fact most clearly demonstrated was that Rat II was utterly ignorant of the whole matter. She made no attempts in the latter part of the series to open the box, apparently quite content to share the benefits after Rat I had done the work, and doing nothing on those days when Rat I was out of humor.

The question raised under experiment 7 as to recognition of the boxes, by Rat I, receives a little light from the subsequent experiments. Absolute certainty is still lacking, but the rapidity, definiteness and precision of her movements in experiment 15, leave little doubt that she instantly recognized Box I. Her actions and manner had all the marks of the *feeling of security*, in contrast with the hesitation and indefiniteness manifested in the presence of Box II. This cannot be attributed to accidental correctness of automatic movements in the former case, for the appearance of security was observable from the moment she approached Box I; whereas her manner was doubtful and hesitating when she approached Box II. My conclusion is that she fully recognized Box I, but that the recognition of Box II was imperfect.

A similar conclusion is compelled in regard to the appropriate actions in each case. Rat I manifestly associated digging in a particular spot with the recognition of Box I. On the contrary, she never definitely associated biting the strips of paper with the appearance of Box II. In connection with biting, she continued to dig, as if supposing that work a necessary part of the process; and, throughout the series, never ceased to butt the door, though this method proved successful only three times, whereas biting was successful in thirteen cases in this series; in the series of experiments with this box under Group II, after the first five experiments, in which cases the door was sprung during a melee of scratching, biting and butting, thirteen cases of biting and only one of butting were recorded as successful. Indeed in the latter part of that series, the clawing and butting movements were almost entirely eliminated. The conclusion seems to be that under the uncertainty experienced in regard to Box II there was a recrudescence of the previously sloughed-off butting movement; and the series was not prolonged sufficiently to effect the re-elimination of this factor.

Series II. Rats III and IV. Followed Series II of Group II.

Experiment 1. Box I. Time, 1½ m. Rat III went at once to the right place, dug a little, in a doubtful manner, with one paw; then climbed upon the box. Rat IV went to the right place and sniffed, but did not dig. Rat III soon returned, dug tentatively till she could poke her nose under the bottom, and then dug with confident haste. The appearance of the rat before that was one of uncertainty and hesitancy. As soon as this clear space was found the recognition became complete. On the second day the movements were less doubtful.

Experiment 3. Box II. Time, 30 sec. Rat III worked quickly and accurately, with no hesitation, barring a little preliminary sniffing.

Experiment 4. Box I. Time, 50 sec. Rat III dug tentatively part way, then climbed upon the box. Returned and dug in. Lacked complete assurance. The following two days gave little difference in results, but in experiment 7 Rat III went instantly to the right spot and dug in confidently. Recognition was precise and immediate, and the appropriate movements were definitely associated.

Experiment 8. Box II. Time, 5 sec. The quickest and cleanest work I have seen. Rat III came around the corner of the box, sniffed the paper once, then seized and tore off both at once. (This, of course, was accidental.) The rapidity and precision of this action leaves no doubt that the box was recognized instantly. The integration of the association between the perception of the box and the appropriate movements was complete.

The six succeeding experiments were with Box I, and show striking uniformity, experiment 9 being performed in 25 sec.; the following 5 in 10 sec. each. Recognition and association here is perfect, no false movements being made.

Experiment 15. Box II. Time, 1½ m. At the end of ½ m. Rat I bit one strip partly off. The strip stuck, and she ran away as if not certain of her ground. After "fooling" a minute she finished the work. (No digging movements.) The rats seem bound to "fool." The next two days the work was quick and clean, 15 and 10 sec., respectively.

The last eight experiments in the following order of alternation: Box I, three experiments; Box II, one; Box I, one; Box II, three; showed that discrimination of the boxes was practically perfect. In experiment 23 Rat III was not hungry, for she gave up the task after making one or two feeble bites at the papers. She recognized the task clearly enough, but lacked the motive to push her efforts to conclusions. Rat IV made no effort to get in; and, indeed, she was a silent partner throughout, as was Rat II in Series I of this group. She merely

took her share of food after the task of securing it had been performed by her companion.

Comparison of this series with Series I brings out some rather striking facts, however. Rat I never perfectly recognized Box II, though she did recognize Box I. On the other hand Rat III, almost from the beginning, showed perfect recognition and discrimination of these boxes. As a correlative of this fact it was remarked that Rat I did not succeed in eliminating all useless movements in connection with Box II; and in selecting, for sole use, the patently most effective method of opening the box. Both of these things Rat III quickly did. This merely emphasizes the variability in the degree of intelligence in individuals of the same variety, a fact of importance in animal as well as in human psychology, which practically, if not theoretically, is too often overlooked. The evident differences in this case cannot be accounted for by fortuitous circumstances, by accidental variations in the manner of starting the associations. There is no external reason why the digging habit should have been retained by Rat I and dropped by Rat III, when dealing with Box II. Nor is the case any better with the persistence of the butting habit. References to my diary shows that Rat III, in the course of Series II, Group II, succeeded once in butting the door open, just as did Rat I in her series; and it shows also that during the latter part of their respective series in Group II both these rats nearly eliminated the butting movement. Its reappearance with Rat I in Group III clearly indicates confusion of images on her part; and this confusion marks her as inferior to Rat III in the power to form and retain a definite useful association and to discriminate two closely similar objects—two very essential factors in the complexus of intelligence.

GROUP IV. *Rats III and IV.* Complication of the problem with Box II. After Rat III had become perfectly familiar with Box II, as related in the description of Group III, the problem was varied and complicated by removing the spring from the door; so that when the papers were removed—bitten or clawed off—the door would remain in position instead of flying open. In order to get the food, the rat, after removing the papers, had to poke the door inward with her nose and crawl under far enough to reach the food. Several interesting and suggestive facts came out in the course of these experiments. These are noted in the following paragraphs. The actions of the rats in the first experiment of this group are best described by the notes taken at the time.

Rat III was apparently greatly surprised that the door did not open after she had removed the papers. She drew back and looked fixedly at the door; she then poked it gently with her nose, but was frightened by the swinging and did not try

to enter. She had pulled off the papers dexterously, dropping them whole in front of the door. These she now picked up and carried into a corner, according to the rat's prudent custom of turning them to account for nest-building. She then came back and poked the door again; then dug all about the front and sides of the box. So she went on for some five minutes, alternately poking the door, and running about and digging. Finally she plucked up courage to poke the door open and enter far enough to get a piece of bread. Rat IV now tried to steal the food, and for several minutes there was a struggle for the prize. The honest rat lost, of course; after which she went back boldly and got the second piece of bread.

There are three interesting observations in the preceding paragraph: the stopping to carry away the papers; the surprise and perplexity manifested when the expected did not happen; and the apparent feeling of the rat that she had done the right thing, as indicated by her constant returning to the door; her digging was only desultory, but her attacks upon the door were pointed and meaningful. All these points bear upon the question of associative formations.

It often happens that the bye-products of a process are hardly less valuable than the chief product. So in this experiment, the accidental manifestation of the working of the rat's mind is of considerable value in determining the *modus operandi* of the associative process. It is certainly significant that a hungry rat stops her quest of food in order to pick up and carry away to a corner some bits of paper. The meaning of this seems to be that the nest-building instinct is so strong, that the mere sight of a bit of available material serves to distract the unstable attention of the rat from her quest of food—hungry as she may be—and turns it to the other function. (I have noticed that the rats always gather up these papers, though they generally eat their suppers first. On several occasions, however, I have seen them carry away the pieces as they took them off, before getting the food; and once, I saw this done by a young female not yet pubescent. The males, too, have the nest-building instinct and do not fail to make a comfortable nest of any available material.) If one were to speculate upon the form of the associative process involved, it might be figured somewhat as follows: The sight of the paper excites the nest-building impulse (the nature of which is not analyzable; the motor element is undoubtedly large, though one could hardly speak of it as a motor image), with its proper affective coloring. This state acts as a starting point for a true motor-image—the impulse to seize and carry away the paper, which impulse or *thought* eventuates in the appropriate action. Whether or not this be a correct transcription of the procedure in the rat's mind,

the incident aptly illustrates the manner in which their associations are formed. Looked at in one way the associations are fortuitous, depending for their form upon external circumstances; but in another and more important sense they are more or less free, depending upon inner conditions. In any given case, the associative process is grafted upon some powerful organic tendency.

The further fact that the rat returned to the original problem immediately after disposing of the papers, suggests a question of some delicacy: How did her mind revert to that problem? The most obvious explanation would be that the sight of the box revived the interrupted association process. The suddenness and directness of the return, however, suggest that the reinstitution of that chain was due to central causes. The start was made before looking at the box. The most probable explanation seems to be the resurgence of the hunger feeling, and with it the half formed associative series, though there is no proof that some other elementary factor of the series was not the connecting link.

If we return now to the conduct of the rat towards the box, after her first surprise, we find another chance for interesting speculation upon the character and form of the associative process. The train already formed may be figured somewhat as follows: feeling of hunger, sight of box, smell of food (these two probably simultaneous), curiosity, location of food in box by smell (and sight), tearing off paper, getting food, pleasurable state. In some instances, as has been noted in considering the preceding groups, the first term of this hypothetical series drops out, and the mere sight of the box is sufficient to start off the train. (It is quite possible that the instinctive acquisitiveness furnishes the organic basis for the series in such cases. It is highly improbable that any excitation of a purely sensational character would furnish the motive force.) The connection of these links becomes so intimate that when the rat is normally hungry the appropriate movements are gone through with immediately upon seeing the box introduced into the cage. Now, when this associative process is broken up at the biting-off-paper point, as in this experiment, by the unexpected failure of the door to open, what happens in the rat's mind? The manifest purpose of the animal is to get inside the box, and this desire to get inside is coupled with the idea of getting in through the door. The modified form of the association train may now be: hunger, a mixed image, motor and visual, of entering the box through the door, getting the food, pleasure. That is, one of the terms of the chain is variable—the association is not determinate. When this term is expunged, another term, perhaps a suppressed one, rises to take

its place. Of course it is not necessary to postulate such a process as the following in the rat's mind: "Biting off paper fails of its usual result, therefore I'll try another method." The only necessary elements are: the persistence of the feeling of hunger, the location of the food inside the box, either as a present smell-sensation or as memory of getting the food inside the box, or both, and the memory of getting in at that place. This last accounts for the constant return to, and the poking of, the door. The rat is at first timid and suspicious of the door, but, as she is not hurt by it, her boldness increases; and this being further stimulated by the smell of the food, finally impels her to force open the door.

The pausing of the rat when the door unexpectedly failed to open might seem to imply reflection; but this is not so in any strict usage of the term reflection. Surprise and disappointment would be quite sufficient to restrain activity for the time; and these affections would preclude the possibility of reflection, unless reflection is used merely in a descriptive sense to designate the transition from this passive state to an active state under the resurging impulse of hunger. That the rat *feels* "why" or "what" is certain, that she thinks "why" or "what" is both doubtful and unnecessary.

If the preceding analysis is approximately correct, it is apparent that the primary determinant of this associative process is the feeling of hunger. But the process is not rigidly fixed. All the terms are variable, even the fundamental term of hunger, for it was shown that, after the problem had been solved, the rats when not hungry would perform the task under the impulse of the hoarding instinct. The carrying of the papers to a safe corner—completely breaking off the box-association—was in obedience to the command of the nest building instinct, the psychical motor accompaniment of the anticipatory maternal feeling.

The succeeding experiments of this group, like those of the preceding groups, showed the ability to profit quickly by experience. Fear of the swinging door gradually disappeared, but did not fade out entirely until the ninth day. Table IV gives the time results of the series. This table shows that fear of the door was not the sole factor in determining the quickness of performing the task. It was, however, the most constant factor, and largely conditioned the first ten experiments. As in all the other experiments the relative hunger of the rats and their instability of attention were influential. The increase in the required time in experiment 5 was due to a different cause. The position of the box relative to the cage was slightly changed, turned one quarter around. This change seemed to disconcert the rat; she went first to the usual place *relative to the cage*. Sev-

eral times she passed around to the door and smelled of the papers, returning each time to the old position, before finally biting off the papers. The sudden increase in time in experiment 11, presents quite a different case. Rat III got the bread as far as the door in 45 sec., but it stuck under the door. Thus baffled, she left the bread and went around the box as if to see what was the matter. She apparently tried once to push the door back with her paw while pulling at the bread with her teeth, but was unsuccessful. This movement was probably not an intentional attempt to push the door open. The explanation rather is that the rat was trying to brace herself and placed her foot against the door for that purpose. Careful observation on this point for several days showed no tendency on the part of the rat to push back the door with her paw, while pulling the bread from under the door with her mouth. In every case of success in getting the bread, the success was due to some accidentally favoring circumstance or to an unusually vigorous pull. The fact that this exceptionally bright rat did not hit upon this obvious mechanical relation, emphasizes the casual nature of the origin of most of the rat's associative processes. It is also clear, I think, that, what properly may be called ideas, find slight place in the associative process. Crass images—visual, olfactory, motor—organic conditions, and instinctive activities are assuredly the main elements. That these elements may bleach out and attenuate into ideas is not impossible. Analogy with human experience would indeed point to that conclusion.

The permanence of the association was demonstrated in the case of this rat by setting her to the problem again after a lapse of forty days. During this time she had not seen the box, but had been fed daily with dog-bread and milk placed freely in her cage. As she had given birth to and partly reared a family of young—her first litter—it would seem that her experience had been sufficiently varied and distracting to have obliterated the memory of the experience with the box. She showed, however, perfect recognition and discrimination, biting the papers off and pushing the door open within 25 seconds.

GROUP V. Character of the Associative Process and Individual Differences in Intelligence. In the preceding experiments two points had forced themselves upon my attention: (a) that the rats severally learned the task set them by doing it themselves; (b) that they manifested considerable individual variations in intelligence. It was to test further these observations that this group of experiments was made. Especially it was desired to note individual differences in intelligence; and, if possible, indicate some of the elements of difference. That differences of intelligence obtain among the lower animals as much

as in man, relative to the range and quality of psychic activity, is, *à priori*, to be expected. General observations, and the experiments already related, had demonstrated this in regard to the rat, but further examination of the matter was not undesirable.

For this group of experiments Box II was used. Four males, eight weeks old, brothers, designated *A*, *B*, *C and D* were the subjects. These rats were kept in a large wire cage, in which was a common squirrel revolver for exercise. They had been reared carefully, and were in perfect health and spirits. From birth they had been handled and petted, so that they were as perfectly fearless as rats ever become. To all external appearance they were as alike as so many peas.

The method was exactly as in other tests with Box II. At feeding time the box with the food inside was put into the cage. In all of the experiments the rats were minutely observed, and the relative ease and quickness, with which they severally built up the definite associative process involved in mastering the problem, were noted carefully. A special effort was made to detect traces of imitation. In a gross way the relative intelligence of the individual rats would be indicated, even if little or nothing were demonstrated as to the elementary character of the intelligence. The time factor is given in Table V. As in the other cases its significance is very general, both in regard to relative intelligence and to familiarity with the problem. It is suggested, however, that the time factor is much more regular in the latter respect with these *more highly domesticated* rats than with the others. They were subject much less to distraction of attention. The following extracts from my journal give the course and the points of main interest of the experiments.

Experiment 1. All four rats ran about in the usual way,—sniffing, digging, climbing over the box, etc. They also gnawed casually at the paper. At the end of three-quarters of an hour they had gnawed off one piece and bitten at the other, but they had made no concentrated effort. They were very "flighty"—running about the box, over their cage, and in and over the revolver.[1] Several times they all sat down in solemn conclave and washed themselves vigorously. At the end of 1¼ hours they succeeded in getting in. Rat *A* was the successful one. The rats are all suggestible—when one digs at any particular place, they all dig there. The same is true in a less degree in regard to clawing the paper.

Experiment 2. Rat A. Time, 1½ m. All ran around ex-

[1] These rats had been kept in this cage about three weeks, and had developed a great fondness for the revolver. They had made their nest in it, and always carried their food into it, whether they ate the food immediately or stored it against a time of need.

citedly for a moment, then *A* attacked the paper. He bit one piece in two, then carefully tore off both the upper and the lower half, as if under the impression that they still held the door. He then bit through the second piece. The work was done quickly, systematically and persistently, though the other rats got in his way and hindered him. They gave him no assistance, however. He knew what he wanted; they did not.

Experiment 3. Rat A. Time, 1 m. Very direct and business-like performance. The other rats crowded in his way, but he pushed them aside and took off the papers in quick succession. (Did not stop for the pieces this time.) He entered immediately, seized a piece of bread, came out, ran quickly and furtively around the cage, and hastily climbed into the revolver to enjoy in peace the fruit of his labors. One could not fail to note his manifest desire to conceal his "find."

Experiment 4. Rat A. Time, 25 sec. None of the other rats made a bite at the papers, though they swarmed in *A's* way and into the box as soon as he got it open. Three of the rats were in the box at once. They came out almost simultaneously, and hastily scrambled into the revolver with their prizes; the fourth one was late in getting into the box, but he came out and tore wildly around the cage—like the wicked when no man pursueth—seeking a place of concealment, though the other rats were busily engaged in the revolver. The absorbing intensity of the desire to "keep," blinding him to the complete absence of all enemies, is one of the striking evidences of persistence of "wild traits" that have been of fundamental importance to the life of his race. A few moments later *A* lost his piece of bread in the litter of the nest, and came back to the box again,—as if remembering his previous *modus operandi*. A nice question arises: whether a real memory image was the determining factor in this action, or whether the coming out was merely impulsive and the apparent purposiveness, due to the sudden sight of the box after leaving the revolver. The latter explanation commends itself as the simpler, but the rapidity and bee-line directness of the action suggests the former.

Experiment 5. Rat A. Time, 20 sec. *A* ran once around the box before biting off the papers. One of the other rats followed him closely all the time and entered the box almost simultaneously with him.

Experiment 6. Rat A. Time, 20 sec. None of the other rats made any attempt to bite the papers. Experiments 7, 8, and 9 were practically repetitions of 6.

A was removed at the end of experiment 9.

Experiment 10. Rat B. Time, 2½ m. There was a considerable interval between the removal of the first and second

papers. All the rats seemed to associate the door with the desired end.

Experiment 11. Rat B. Time, 1 m. *Experiment 12. Rat B.* Time, 20 sec.

Rat *B.* was removed at this point.

Experiment 13. Rat C. Time, 2½ m. Rat *C* paused several times at the door before making a trial. Finally he bit off one piece. This seemed to give him confidence and he quickly tore off the other piece. *D* made no attempt.

Experiment 14. Rat C. Time, 3½ m. *C* bit off one piece at the end of 1½ m. He seemed surprised that the door did not open. He nosed around and gnawed a little at the woodwork of the box, but made no serious attack upon the second paper until 2 m. later. He was distracted by hearing rats eating in an adjoining cage. *D* made no attempt to bite the paper, though he was close beside *C* when he pulled off the first paper —their noses were almost touching.

Experiment 15. Rat C. Time, 2 m. The rat made three determined bites at the papers before getting one off. He ran all around and over the box after each trial. *D* followed closely. After *C* had pulled one piece half off, *D* caught the suggestion and pulled at the hanging paper. Then they played with the piece they had removed for about a minute, chasing each other like kittens. Imitation?

Experiment 16. Rat C. Time, 1¾ m. *C* removed the first paper in ½ m.; then played a minute before removing the other one. The rats were not hungry, for they had several small bits of bread stored away in the revolver. Their performance of the task without the incitement of hunger can hardly be accounted for except upon the basis of a hoarding instinct almost as imperative as hunger.

No further tests were made with *C* and *D*.

Rats *A* and *B* were tested again after the lapse of five days. Memory was perfect. Both rats attacked the papers, *B* getting off his piece first; *A*, the other piece immediately after. Twenty-seven days later this test of memory was repeated under circumstances so different as to warrant the expectation that there would be some hesitation; on the contrary the rat—it happened to be *A*—instantly attacked and tore off the papers—so definite and permanent was the association.[1] Time, 10 sec.

The results of these experiments in general served to confirm the observations and conclusions previously made in regard to the origin and the nature of the associative processes. The permanence of the association was confirmed and the impor-

[1]The conditions will be given in detail in connection with another experiment to be described in a later paper.

tance of the motor element in the memory was emphasized. There were several suggestions of imitation. These will be estimated in connection with the following group which deals particularly with imitation.

These experiments confirmed also the observations upon individual differences in intelligence. It is certain that some rats show more initiative and learn the tasks more quickly and easily than others. If we eliminate the elements of accidental first success and of distractions, the fact is not impaired. Interpreted more rigorously all the tables point that way. If we take the term intelligence in its obvious biological significance as the adaptive function of the organism by virtue of which definite useful associations (habits) are formed, then the demonstration of differences is clear. Upon what particular element of the intelligence-complex the particular variations depend can only be guessed at. There are, however, some noticeable facts in the results. (a) The most striking fact observed was the apparent superiority of these young rats over the adults used in the other experiments. Comparison of Table V with Tables II and III shows the superiority of these young rats over all the adults that were tested. Rat IV, *e. g.*, had experience of this apparatus for weeks in company with Rats III and II respectively, but did not learn the task in all that time; and Rat III, the brightest of the adults tested, presents a poor record in comparison with that of Rat *A*. (*A* reduced the time to 1 m. in experiment 3, and thereafter did the work in 30 sec. or less; while Rat III reached the 1 m. mark only in experiment 7, and varied thereafter for several days from 15 sec. to 4½ m. It is to be observed, also, that *A* succeeded in the first trial; III did not succeed until the fourth.) A detailed comparison would show a similar superiority of these young rats throughout. (b) A second fact of interest is that these rats were males. I am not prepared to contend that the male rats are more intelligent than the females, but this points that way. The young females used in connection with Group VI (*q. v.*) showed no more intelligence than the adults, while the adult male used in Group VI displayed more initiative than female IV. The comparison is not conclusive, however, for the young females in question were younger than the young males. The explanation may be in the greater activity and vitality of the males whereby their chances of hitting upon the right action are increased, while at the same time they are endowed with greater initiative. Superior vitality and activity doubtless is also one of the advantages of youth. (c) Another point worthy of notice is that these rats had become about as tame as possible. I am inclined to think that their almost complete freedom from fear was a very important factor in their superior intelligence.

The other rats were all more or less wild when I received them. The modification in character of these four was somewhat striking. It is not improbable that some information in regard to psychic variations may be had from studies of successive generations of animals under varying controlled conditions. The advantage of such studies is obvious, both for individual and genetic psychology.

The differences between particular individuals exist only within very narrow limits. They are almost solely in regard to the quickness and ease with which the associations are integrated and retained. Rat I, for instance, was inferior to Rat III in both respects, and, as pointed out before, Rat *A* was markedly superior to Rat III. The differences between the four young males were slight, but appreciable. No variation in method of performing the task appeared among them, though slight variations were noted among some of the adult rats.

In the way of explanation of the differences nothing more can be said than that they depend upon a complex body of interacting traits,—functional, muscular, perceptional, affective and other—correlated with corresponding physical characters. In a word it is a matter of organization. The means for analyzing further the difference between any two given cases are not at hand. As between *A* and *C*, for instance, it is impossible to say whether the difference lies in the neuro-muscular system, or in the organ of association, or elsewhere. It can only be shown that appreciable and definable differences do exist.

GROUP VI. Imitation. In this group an attempt was made to throw further light upon the matter of imitation. Many of the preceding experiments gave no evidence of imitation of any kind, others indicated a low form, about equal to motor suggestion, and in the last group there were some cases that seemed to imply a higher form. Being convinced that Rats II and IV had not profited by their companionship with the successful Rats I and III, I removed them from their respective cages and placed them together in another cage. They were tested then with Box II. The belief that they had not solved the problem, either by doing it themselves or by seeing it done, was confirmed. In spite of the fact that they had seen their successful companions perform the task not less than twenty times, they showed no acquaintance with the proper procedure. Table VI gives the numerical results. The conditions were exactly as in the preceding experiments. In experiment 1 of this group, Box II, containing food, was placed in their cage 24 hours after their last meal. The rats ran around and over the box, pawing, digging, sniffing, and occasionally biting at the wire mesh of the sides; but they showed no sign of recognition of the proper means of entrance, no more than if they had never seen the box before. At the

end of half an hour I removed the box without feeding the rats. The experiment was repeated at the same time the following day, with the result that Rat II got into the box in 2 m. She accomplished this not by biting or clawing the paper, but by butting the door with her nose (the papers adhered rather weakly). The movements of both rats were vigorous in proportion to their hunger. They wasted no time. They seemed, moreover, to locate the door as the point of attack, but without any definite method in their movements against it. The butting appeared to be accidental. In the third experiment the papers were fastened securely. Both rats clawed, bit and butted. I was unable to see which one was successful, but the fact that it was Rat II the day before and the succeeding days, leaves little doubt on the point. The association did not become *solid* in her case until the seventh day. Before that time her movements were somewhat aimless—running around and over the box and digging away the sawdust. The movements on the seventh, eighth and ninth days were so definite as to leave no doubt that she recognized the situation immediately. The marked increase in time of the three succeeding days was due to other causes than unfamiliarity—accidental distractions and variation in degree of hunger.

There was, in this case, an interesting variation of the *modus operandi* in getting the door open. Apparently the successful "butting" of the second day made a lasting impression, for the rat persisted in this mode of attack, resorting to biting only as a secondary means; and several times she succeeded in butting the door open after biting off the first paper.

As in all the preceding experiments, the inveterate "fooling" tendency was manifest. Rat II frequently would run several times around the box, pausing each time at the door, before making a real attack. This indecision appeared at times to be mere playfulness; at other times the rat seemed to be looking for an easier method of entrance, for she performed the task definitely enough when she got ready. Another possibility is that it was merely stupidity, the proper action not being suggested at first. The association was inhibited in some way. Whatever may be the explanation, this characteristic renders impossible the representation of the gradual perfection of the associative process by a uniform time curve, and complicates the analysis of the process.

After Experiment 12, Rat II was removed and a fresh rat, a male, *Z*, was put with Rat IV. They manifested equal ignorance of the process of getting into the box, the new one actually making the first purposive attack upon the door. He succeeded in pushing it open, the paper adhering loosely. On the second day, the door was more carefully secured. Neither

had succeeded at the end of ten minutes, so the box was removed.

After Rat IV was separated from Rat III, a half grown female was put with Rat III. The use of Box II was continued. The results of these experiments also weigh against imitation as an agency in the process of learning the task. In nine trials, this rat gave no evidence of imitating Rat III in getting into the box. Five experiments with another rat of the same age gave similar results. In the latter case the young rat learned the task quickly, but this was due to the fact that she happened to be hungry and eager two or three days when Rat III was inactive.

My conclusion from all this experimental work, and from much other observation of rats is that they do imitate, but that imitation with them is relatively simple. They imitate simple actions; but I have seen no case of what may, in lack of a better term, be called inferential imitation. By this I mean merely: learning to do a thing by seeing another do it—the purposive association of another's action with a desired end. For example, not one of the eight rats that might have learned to open the door of Box II by seeing another rat do it, ever thus profited by such experience. Each rat learned the task for himself, and learned it by doing it. On the other hand imitation of simple actions is of frequent occurrence. Very often if one rat begins digging, all are eager to dig in the same place; if one runs over the box, over the box they all go. This kind of imitation is exhibited in some simple experiments with the common squirrel revolver previously mentioned.[1] This was kept in a large cage containing several rats. In numerous tests by this method it was observed that almost invariably when one rat climbed into the cylinder others would follow. Such is also the form of imitation noted in the diary of the young white rats, where the young one imitated the action of the mother in pulling at a piece of excelsior.[2] This simple form of imitation depending upon the immediate functional connection between sensory and motor centers in a lower level—like the frown of a three months' baby when the nurse frowns—covers all the cases of imitative action I have observed in the course of these experiments. The fact that Rat *B* took so much less time than Rat *A* in learning to open Box II might be interpreted as evidence

[1] *Cf. Amer. Jour. Psy.*, Vol. X, No. 3, p. 425. "After the rats have learned to run the revolver a test of imitation may be made by introducing uninitiated rats into the cage. The difference in the time required to learn the lesson may be taken as a rough measure of imitation."

[2] Small: Notes on the Psychic Development of the Young White Rat, *Amer. Jour. Psy.*, Vol. XI, No. 1, pp. 87, 100.

that *B* had profited by *A's* experience, and, consequently, as evidence of the higher imitation. The assumption is unnecessary. *B* had profited by *A's* experience to the extent of associating the getting-into-the-box with the locality of the door, thereby eliminating the many useless movements around and over the box that a perfectly "green" rat would have made. The recognition of the door as the point of attack is probably due to his having entered there rather than to his having seen *A* strip off the papers.

Logically, however, this lower form of imitation might explain a more difficult case than the preceding. Suppose that one rat is led by immediate suggestion to imitate the simple action of another in gnawing the paper: *i. e.*, while one is at work, the other comes along and without any idea of the end begins to gnaw also—just as the young one referred to pulled the excelsior. The paper gives way and they both go in. The association is now started between gnawing at this particular place and getting the food, and may be perfected later. The imitative factor consists solely in the impulsive imitation of a simple action.

Wide as are the explanatory possibilities of this lower form of imitation, it is difficult to demonstrate that higher forms do not exist. In dealing experimentally with this matter there is one highly important factor that cannot be controlled completely, *i. e.*, attention. Distractions may be minimized almost to the vanishing point, but that point cannot be reached with such a psychically unstable compound as the rat mind. Even if external distraction were entirely eliminated, there would still be the insuperable obstacle of subjective conditions. And the conditions are distinctly unfavorable for demonstrating the higher imitation. The attention of the rat is focussed, under the compelling feeling of hunger, upon getting at the food. The call is for individual action. Attention is turned away from the actions of his companion. It is not impossible that a form of imitation, involving the higher associative processes, might be demonstrated if it were possible to direct the attention of the rat to the actions of the other rat, while retaining undiminished the affective basis for action. Any attempt, however, to restrain or constrain the animal would defeat the desired end—attention would assuredly be diverted from the objective point to the restraining conditions—would be lost in the affective absorption induced by them. An illustrative case is an experiment recorded by Dr. Thorndike[1] in his experiments with cats. In this case the experimenter tried to instruct his cats to perform certain acts by holding the paw and guiding its

[1] Animal Intelligence (*Psychological Review*, Monograph Supplement, No. 8, June, 1898), page 70.

movements successfully. "I took the right paw and, putting it against the lower or right-hand side of the button, pressed it round to a horizontal position." Three cats were tried, but none learned to do the act this way, although the lesson was repeated several times. This method manifestly disregards the factor of attention above adverted to, and consequently fails to demonstrate the absence in animals of those higher associative processes involved in inferential imitation.

The matter is still open, though my own observations upon the rat predispose me to regard the explanation in lower terms as probably correct in the case of that animal. It would seem that the rat is probably incapable of attending in such a way as to bring the relation of perceived means and end into focus; and consequently incapable of higher imitation.

It cannot be assumed, however, that this presumptive conclusion, even if it were more certain, can be stretched to include the imitative processes of all other animals below the primates. (There is hardly any doubt in regard to the primates.) The mental divergences among species, and even among varieties, are so great as to preclude any crass generalizing. However strong one may feel the *à priori* assumption to be, definite conclusions must wait upon more abundant concrete evidence and the fuller returns of comparative neurology.

TABLE I.

Exp.	Series 1. Time.[1]	Series 2. Time.
1	90 —	35 —
2	8 —	2:30
3	2:30	2 —
4	3	1 —
5	3:30	1:30
6	2:30	— 30
7	1 —	1.30
8	5 —	— 30
9	1:30	
10	1:45	— 10
11	1:30	— 15
12	— 30	— 10
13	— 45	— 10
14		— 18
15		— 15
16		— 30
17		— 40
18		
19		— 20

TABLE II.

Exp.	Series 1. Time.[1]	Series 2. Time.
1	10 —	Failure.
2	14 —	"
3	3 —	"
4	2 —	Indefinite.
5	3 —	3 —
6	1:30	2 —
7	1:30	1 —
8	3 —	4:30
9	1 —	5 —
10	— 30	— 15
11	— 30	1 —
12	— 30	— 50
13	— 15	
14	— 35	
15	— 10	
16	— 20	
17	— 35 .	
18	— 10	
19	— 20	

TABLE III.

Exp.	Series 1. Box.	Series 1. Time.[1]	Series 2. Box.	Series 2. Time.
1	II	1 —	I	1:30
2	II	— 30	I	— 30
3	I	1:30	II	— 30
4	II	1:20	I	— 50
5	II	— 50	I	1 —
6	II	——	I	1:30
7	II	— 50	I	— 25
8	I	— 30	II	— 05
9	II	——	I	— 25
10	II	——	I	— 10
11	II	1:10	I	— 10
12	II	— 30	I	— 10
13	II	1 —	I	— 10
14	II	— 30	I	— 10
15	I	— 10	II	1:30
16	I	— 20	II	— 15
17	I	— 20	II	— 10
18	II	— 45	I	— 15
19	II	— 25	I	— 10
20	II	— 25	I	— 10
21	II	1 —	II	— 15
22	II	——	I	— 15
23	II	— 35	II	——
24	II	——	II	— 30
25	II	1 —	II	— 30

[1] The time is in minutes and seconds in all the tables. The long dash in the time column indicates that the box was removed after 5–10 minutes.

TABLE IV.

Exp.	Time.
1	5:30
2	3 —
3	3 —
4	2:30
5	5 —
6	
7	3 —
8	1 —
9	— 50
10	— 10
11	2 —
12	— 20
13	
14	— 20
15	
16	— 55

TABLE V.

Exp.	Rat.	Time.
1	A	75 —
2	A	1:30
3	A	1 —
4	A	— 25
5	A	— 20
6	A	— 20
7	A	— 20
8	A	— 30
9	A	— 30
10	B	2:30
11	B	1 —
12	B	— 20
13	C	2:30
14	C	3:30
15	C	2 —
16	C	1:45
17	A&B	— 10

TABLE VI.

Exp.	Rat.	Time.
1		——[1]
2	II	2 —
3	II	3 —
4	II	3 —
5	II	3 —
6	II	2 —
7	II	— 30
8	II	— 30
9	II	— 20
10	II	1:15
11	II	— 50
12	II	1 —[2]
13	Z	1 —
14	—	——
15	IV	5:30
16	Z	2:30

[1] Removed at end of ½ h.; neither got in. [2] Interval of 4 d. between 11 and 12.

PSYCHICAL LIFE IN PROTOZOA.[1]

By G. P. WATKINS, A. B.

Any one of the higher animals, it is commonly held by modern physiologists, is a colony of unicellular organisms. Hence the cell in its free and undifferentiated state should possess, in some elementary way, all the properties which are later highly developed through specialization in the metazoon. The following words of Verworn are perhaps representative of the present attitude of physiologists: "Elementary life phenomena are inherent in every cell, whether it be a cell from the tissues of higher animals, or from the tissues of lower animals, whether it be a cell of a plant, or, lastly, a free cell, an independent unicellular organism."[2] Among these properties of the original free cell must have been something corresponding to mentality, Mind has not been superadded in the course of animal evolution. As Cope says: "The conscious cell is the primitive cell, and the unconscious cell is the modified or specialized cell."[3] The cells of the brain have been perfected with reference to psychical attributes, but, again in the words of Cope, they are "the least modified of all those that constitute the soma of the metazoon, and thus they resemble most nearly the simple beings which constitute the lowest forms of the Protozoa."[4]

From all this it should follow that a specialized nervous system or a high organization is *not* a precondition to mentality but that mentality in some sense is a property of the original cell.

If the above theory be accepted, we have, in the evolution of the higher organisms, a compounding of minds. The human being is a colony psychologically as well as biologically. There are specialization and interdependence of diverse elements, and the unity is not the unity of a simple thing, but that of a system. Thought is an aggregate function.

Prof. James, however, objects that mental states cannot be compounded and cannot be composite. But this is only one aspect of a very general difficulty for him. For he says: "Atoms

[1] From the Psychological Seminary of Cornell University.
[2] *Monist*, art. "Modern Physiology," Vol. IV, p. 371.
[3] *American Naturalist*, art. "Evolution of Mind," Vol. XXIV, p. 903.
[4] *Ibid.*, 903.

of feeling cannot compose higher feelings *any more than atoms of matter can compose physical things*" (italics mine); and, also: "The thing we name has no existence out of our minds."[1] Thus is involved the question as to what is the nature of a compound in general. And it must be admitted that, from a philosophical point of view, though mental states have the form of time, and some of them that of space, one can know directly only a single mental state in isolation. In going beyond the mental state as such, there is a sort of inference. If several mental states connected in experience are jointly referred to various *attributes* of a particular *thing*, it is an inference. If, under certain conditions, some of these *things* disappear more or less completely, and we have in their place another *thing* with attributes more or less different, this we name a *compound*. This compound, it must be admitted, is such only with reference to its effects on us. But is anything else, so far as we know it, what it is, except with reference to its effects on us? As to what occurs apart from us, we can only infer, can only symbolize. But symbolize we must. It is our nature to construct a world-order by such inference. And among notions found of use in this process is that of a compound,—a something which, under certain circumstances, takes the place of, or results from the union of, several other things. We need not be able to recognize the elements in the compound; we never do in chemistry. We need not be able to picture to ourselves under the forms of space and time the mechanism of the process of compounding. We do not usually, and ought never to think of a compound as the mere sum of its elements,—and this is the mistaken position against which Prof. James' argument is really directed. We recognize that a compound is itself and not something else. The sum of the matter is that the elements have been lost in the compound; in which they may seem to leave no traces.

A compound in this sense is just as conceivable, applied to mental states, as it is for chemical elements. There is no "assumption that our mental states are composite in *structure*, made up of smaller states conjoined" (italics mine), as Prof. James says there is.[2] "Resemblance," it is admitted, "cannot always be held to involve partial identity."[3] But partial identity with elements is no essential feature of a compound; and, furthermore, the statement is too weak, "cannot always" implying "can sometimes." "If one feeling feels like no one of the thousand" of which it is composed, it nevertheless can "be said to be the thousand"[4] in the same sense that water

[1] *Principles of Psychology*, Vol. I, p. 161.
[2] *Op. cit.*, I, 145.
[3] *Ibid.*, 158, ftn.
[4] *Ibid.*, 163.

may be said to be composed of hydrogen and oxygen. According to the usage of language a thing *is* its elements related or conditioned in a particular specified way, or *is composed* of such and such elements, simply enumerated. Nobody maintains that a compound is its elements under no matter what conditions; but only that it contains them. If the "mind-stuffists and associationists" say "that if the states be posited severally [under certain conditions, let us add] their collective consciousness is *eo ipso* given; and that we need no farther explanation or 'evidence of the fact,'"[1] they are doing no more than the chemists who say that, given free hydrogen and oxygen gas under certain conditions of position and the advent of something hot enough, and you have water. It is wholly a question of factual connection in experience, beyond which we cannot go. Nobody says unqualifiedly that the series of states is the awareness of itself,[2] but rather that the series under certain circumstances carries with it awareness of itself. The latter may be "evolved"[3] out of the former in the same sense that anything is evolved out of other things. Composition is not the mere summation or mixing or juxtaposition which Prof. James, with resulting irrelevancy, assumes it is.

Let it be admitted that compounding consists only in a merging or losing of one set of effects to form a new set, and that an aggregate unity exists for the subject only.[4] All the identity we can allege is the inferential identity of substance or support,—something beyond our experience. But mental states can be compounded in the same sense that any other things can be, and the concept of psychical as well as of physical compounds is found to be useful. Whether the "soul" is that upon which these effects combine is another question. Prof. James does not quite dare to go so far as to maintain that the "unitary" character of mind demands that all impressions be concentrated at a single point or a single cell of the brain, yet his leaning towards a theory of a central or "pontifical cell"[5] strongly reminds one of Descartes. But nothing is explained by going to the substance behind mental states, whether the name given be soul or something less objectionable. Science has no use for such an hypothesis. We do not even know what "unity" means, as predicated of this substance. Hence we can accept compounding as a phenomenal fact in the one sphere as well as in the other.

To be taken in connection with the position of Prof. James

---

[1] *Ibid.*, 162.
[2] *Cf. ibid.*, 162.
[3] *Cf. ibid.*, 160.
[4] Royce in James, *op. cit.*, I, 159.
[5] *Ibid.*, 179–81.

just touched upon is his attitude towards the relation between the mental and the physical. He thinks it "the ultimate of ultimate problems . . . . why and how such disparate things [as thought and brain] are connected at all."[1] This "why and how" means for Prof. James, I suppose, as for many, reducing the connection of thought and brain to figuration in the spatial mode of perception. The difficulty is that we cannot picture in this way a mental state, nor can we thus represent its connection with a thing that we can picture, *i. e.*, an extended object. The relation cannot be thought of mechanically, in terms of space. But the factual connection remains the same, and it is with this that we are concerned. Color and form are "disparate," but they are both perceived in the space mode. Is this the essential thing rather than the fact of connection?

There are difficulties, too, in any other than the "mind-stuff" or composite interpretation. It is quite possible to accede to the implication of Prof. James' challenge, "If evolution is to work smoothly, consciousness must have been present at the very origin of things."[2] It is perhaps better, however, from a methodological point of view, for us, as psychologists, to contemplate the possibility of carrying back mind only so far as we find life. Here the principle of continuity may help us; but the question is one of the interpretation of evidence. Prof. James, however, is not so good an evolutionist.

What, for instance, are we to do with secondary reflexes? Prof. James says: "Either lack of memory or split off cortical consciousness will certainly account for all of the facts."[3] This is, indeed, taking liberties with memory. It is just when one is intently occupied with some train of thought that one is most likely to respond to stimulus reflexly; and at this time anything crossing consciousness to interrupt this train (for "we cannot have two feelings in the mind at once")[4] would be especially likely to be remembered. As for the "split-off cortical consciousness," it is quite in accord with the theory that James opposes, but may an individual have several *unitary* "souls" or minds? So, it seems, the real difficulty of pointing out where this "disparate" element, consciousness, enters in, both in the development of the individual and in the animal series,[5] is far greater than any imagined metaphysical

[1] *Ibid.*, 177. [2] *Ibid.*, 149. [3] *Ibid.*, 165. [4] *Ibid.*, 157.

[5] Pres. Jordan has an article on the "Evolution of Mind," in Appleton's Pop. Sci. Mon. for Feb., 1898, also reprinted in "Footnotes to Evolution." The article has great *popular* value because of its attitude towards continuity, but it is quite inadequate psychologically, as it assumes, without hint of possible difficulty, that consciousness evolves from reflexes.

difficulty about the intelligibility and conceivability of compounds, both physical and psychical. Acquired reflexes show that there is no chasm between conscious and unconscious action.

Continuity, too, unless the survival value of consciousness is done away with, is necessary for the explanation of instincts. One view would make complex reflexes and instinctive actions mental degenerates. Another would evolve mind from reflexes. But where is the limit to such mechanical or reflex and instinctive adaptation? When would the uncertainty introduced with consciousness be an advantage to the organism? Logically, the second view makes consciousness an epiphenomenon, man an automaton, and his mind no part of the mechanism. Furthermore, on the supposition of "disparateness" in reality as well as in fact, consciousness could hardly be other than an epiphenomenon correlated with a certain complexity of nervous organization. But the relation is not satisfactory. Why should there be such a correlation? And where would be the line between conscious beings and the unconscious? Our knowledge of reflexes, inherited and acquired, does not lessen the difficulty. These facts point to some theory according to which consciousness would be correlated with hesitation, indecisiveness, and imperfection in the ordering of reaction, rather than with complexity. It is difficult to see how such an incipient consciousness at the stage of complicated reflexes could be other than disastrous. Adaptation of species could, *ex hypothesi*, be perfectly kept up by mechanico-organic variations. Incipient consciousness in the individual organism would be disadvantageous because of loss in rapidity and accuracy of reaction. The little adaptability to change in environment would probably be not sufficient to outweigh this disadvantage, and even that little would be but a duplication of means to an end already attained by purely physical or organic variation in the species. And, since the physical can do this adapting, if it can do so much besides in the way of complex reaction, why should there be any mental at all? What opportunity is there for it even to come on the field?

A primitive consciousness, on the other hand, may have been of survival value. It would have had to compete only with the simplest, even merely chemical, forms of reaction. Its incipient complication of modes of action would probably be of high adaptive value. It is not impossible that the great function of consciousness in the animal world is the building up of complex modes of reaction. The fixity of the reflex is perhaps a later stage in which mind is largely relieved of the care of completed modes of reaction. In the development of species consciousness may thus in some cases have even been quite lost by adapta-

tion. With consciousness accompanying life at the start, indefinite variation in the mental as well as in other matters organic should be expected, so that mind would be moulded by its environment into forms of survival value. Not only could conscious adaptation, through the inherited effects of habit, aid in the formation of instincts and reflexes, but it has perhaps also done more than we suspect in developing the potentialities of organized matter.

Although it has not been necessary, for present purposes, to distinguish between two separable problems involved in this discussion, it may be well here to touch upon the bearings of a possible distinction. Prof. James attacks indiscriminately "mind-stuffists and associationists." But the problem of the compounding of minds is different from that of the compounding of sensations, and the difference is not wholly that between the subjective and the objective points of view, since the minds compounded would scarcely be thought of as becoming each a particular sensation in the resulting mind. What seems to be the best attitude toward the problem of the compounding of sensations has already been indicated. As for the compounding of *minds*, it seems to the writer that the question is one of fact, and that the answer is implicitly taken for granted by modern psychology. No one finds a difficulty, either in the addition of "minds" or in the fact of co-operation, when, in the course of evolution, more cells than before come to perform the mental function. Nobody maintains that less than a plurality of cells function during, and by necessity coincidentally with, the consciousness of an individual.[1] The doctrine of psychophysical parallelism itself involves a multiplicity of cells functioning in unison, with activity not in a single point, but in an area of the cortex necessary for the conscious accompaniment. If it be still objected that we cannot *see how* this compounding of minds could take place, the difficulty is probably due only to what is in some sense an *idolon tribus*, our habitual mechanical mode of thinking.

Thus, it is hoped, have been removed any *à priori* difficulties in the way of admitting consciousness in the organic world wherever the facts seem best explained by supposing it present. There is no reason why we should admit consciousness only at the latest possible stage of evolution. We have to admit it as a *vera causa* somewhere. We should be ready, then, to admit it, always guarding against anthropomorphism, at whatever degree of complexity the evidence warrants. And we should also use it, with due regard for continuity, in a way to give the best

[1] But *cf.* the leaning in James' "pontifical cell," pp. 179-81.

theory of organic life as a whole, both physiological and psychological.

M. Binet has collected an interesting body of facts bearing on the habits of some micro-organisms, which, he seems to believe, have "psychical life." Yet in one place he says: "We are not in a position to determine whether these various acts are accompanied by consciousness, or whether they follow as simple physiological processes."[1] Furthermore, he does not discuss the interpretation of these facts, though, since most of the facts themselves seem to be accepted, this is really the critical point.

Have protozoa psychical life? This again involves the question: What is the objective criterion of mentality? And the answer to this must have reference to the essential nature of mind,—a question not to be settled by characterizing mind as having "consciousness," for this term means hardly more than mind in the concrete, perhaps with an implication of *self*-consciousness.

In predicating mind of some other being than myself, I am inferring the existence of something of which I can have no experience. My direct knowledge is limited to my own consciousness. Inferring the presence of mind in others, I proceed by analogy and by comparison with my own acts objectively considered. Resemblance to me in respect of possessing consciousness is inferred (so far as I arrive at the conviction rationally) from resemblance in other respects. Therefore the cogency of evidence diminishes as I recede from minds like my own.[2] Yet there must always be some quality in common with my own mind,—the quality, too, if the word 'mind' as thus used is to be susceptible of definition at all, upon which that definition depends.

On the criterion of mentality, Romanes' position is perhaps the most important, and as nearly typical of current views as any. He says: "Ejectively considered, the distinctive element of mind is consciousness, the test of consciousness is the presence of choice, and the evidence of choice is the antecedent uncertainty between two or more alternatives."[3] Still he thinks that complexity and unpredictability are not enough, but that we must know the non-mechanical character of the act or the mentality of the agency,[4]—which position is not very satisfactory, since these are just the things we should be uncertain about. Again, he says, "it does not follow that all adjustive

[1] *Psychic Life of Micro-Organisms* (trans.), Chicago, 1897, p. 61.
[2] So Romanes, *Mental Evolution in Animals*, p. 22.
[3] *Mental Evolution in Animals*, p. 18.
[4] *Ibid.*, 19.

action in which mind is concerned should be of an antecedently uncertain character;" but by independent evidence [independent of any particular case of antecedent uncertainty, presumably] we may know that the agent is mental,[1]—which is a necessary precaution, since with greater knowledge of human nature and circumstances comes greater predictability of acts; but this does not reduce the province of mind. For Romanes all that is meant in the objective sense of mental adjustment is that it is "of a kind that has not been definitely fixed by heredity as the only adjustment possible in the given circumstances of stimulation."[2] But "it is not practically possible to draw a definite line of demarcation between choosing and non-choosing agents."[3] The common sense distinction is valid, as in zoological classification.[4] It is asked (significantly enough): "Does the organism learn to make new adjustments, or to modify old ones, in accordance with results of its own experience?"[5] Heredity cannot have provided in advance for alterations in its own machinery.[6] But there may not be enough mind for the learning to make new adjusments, or there may be defective memory, and some parts of our own nervous system not concerned in consciousness may learn by experience.[7] The practical danger is in not seeing mind enough.[8] The criterion is of "the upper limit of non-mental action, not of the lower limit of mental."[9]

The above gives the view of Romanes on the criterion of mentality. The vagueness and inconsistency that strike the reader are not due to misrepresentation. Other psychologists and biologists, also, take positions similar in this as in other respects.

M. Binet accepts Romanes' criterion of choice,[10] but seems not to know definitely how it is to be used, or what results it may give.[11] Prof. James says: "The pursuance of future ends and the choice of means for their attainment are thus the marks and criterion of the presence of mentality in a phenomenon;" the end is fixed while the pathway may be indefinitely modified.[12] The beginning for Cope is conscious memory, with the consequent possibility of more exact adaptation or design in an act.[13] Rapid and transient response in direct answer to certain changes in the environment seems to be Prof. Lloyd Morgan's criterion of mentality.[14] Wundt's view is this: "That the creature knows its proper food, and may be determined in its knowledge of it

[1] *Ibid.*, 18. [2] *Ibid.*, 18. [3] *Ibid.*, 19.
[4] *Ibid.*, 19. [5] *Ibid.*, 20. [6] *Ibid.*, 21.
[7] *Ibid.*, 21. [8] *Ibid.*, 21. [9] *Ibid.*, 22.
[10] *Op. cit.*, 109. [11] *Ibid.*, passim. [12] *Op. cit.*, I, 7-8.
[13] *Loc. cit.*, 905.
[14] *Animal Life and Intelligence*, p. 243.

by previous impressions, is regarded as the first and primal indication of the presence of animal, *i. e.*, mental life."[1] Memory, he believes, is presupposed in cognition, and the presence of cognition is the point to be proved.

Most of these positions are to be criticised for admitting more or less of the subjective, and none are perfectly definite and satisfactory. Purpose and choice, moreover, taken directly as evidence of the workings of mind in the animal world may, since Darwin, readily excite suspicion. There are, however, suggestions in nearly all the above, as well as even more plainly in Romanes, which point toward, and weigh in favor of, what may, perhaps, be the true or best criterion of mentality.

If we define mind by reference to consciousness, what then is consciousness? Mind has the function of producing in the acts of an organism adaptation to environment by direct adjustment. It is the accessory of reaction, the director of action. Our ideas and feelings have reference to motion or its inhibition. The mind is aware of effects and symbolizes causes. The presentation, or representation, or other form of *symbolization* of some environing circumstance, it seems, may be the distinguishing attribute of mentality. For the development of this characteristic power of symbolization, retention or memory is necessary. Discrimination is but a means to more adequate representation. Symbolization, then, is the essence of consciousness.

In view of the function of representation, would it not follow that learning by experience, and the alterableness of action that this implies, furnish the best objective criterion of mentality? There would, in that case, be an intelligent as well as a selective response to environment. There would be *rectification* of action in the fullest sense. Selection, of kinds at least, may be merely mechanical, and it certainly may be merely physiological or unconsciously reflex. But what can sudden alteration in action as a result of experience, without a difference in environment, mean, other than a changed idea of the environment and better knowledge of its effects? Mere physiological habituation would come more gradually.

"Learning by experience" as the criterion of mentality is not new. The suggestion came to the writer from a critical study of Romanes' "Mental Evolution in Animals," ch. I. Though only incidentally, this criterion is actually given in so many words. Since committing to paper his ideas on this subject, the writer has been confirmed in this position by finding that the same criterion has been used explicitly by at least one biologist, while others have had practically the same idea. Dr. Bethe, although his psychology is bad enough, expressly makes

[1] *Lectures on Human and Animal Psychology* (trans.), p. 347.

modification of action through experience the test of mentality.[1] His "Lernprocess," "Erinnerungsprocess," "Lernfähigkeit" are only too rigidly used. After the manner of many biologists, he would exclude mentality till we are sure of its presence. He does not regard the requirement that mind must have evolved considerably before this test is applicable, and, though he explicitly explains the rise of mind by survival value in the face of selection,[2] he overlooks the difficulty touching reflexes. Rabid Weismannism also affects his views. Another biologist, Prof. Loeb, makes "associatives Gedächtniss" the criterion,[3] but in application it seems to be practically identical with learning by experience. He is to be criticised for going to the inferred subjective process instead of stopping at the simple objective fact.

Thus we seem to have a sure test for the presence of consciousness, but it is not necessarily the only one. Another criterion may be preferences unaccountable without reference to an affective element. This seems to be the essence of the choice criterion as M. Binet uses it. Such a test, however, should be employed with great caution, because so much of this unaccountability may be due to our ignorance. But especially preferences different and even opposite with change only in degree of stimulation—instance the reaction of bacteria to oxygen—cannot easily be thought of as merely mechanical, a simple *tropism*. The broader use of the criterion of choice, on the other hand, at least as applied to test the presence of consciousness in particular acts, seems to be valid only so far as implying alterableness and resourcefulness in action, *i. e.*, learning by experience. The reader notices this element in Prof. James as well as in Romanes.

Learning by experience, indeed, is not an all-sufficient and final criterion of whether a being is to be considered mental or non-mental. It is a *sure* test of the *presence* of consciousness, partly just because it requires a considerably evolved consciousness, and this we cannot suppose came into being *de novo*. Lack of mentality is not proved by absence of evidence for learning by experience. Symbolization does not necessarily imply the power of change in symbolization. Those biologists are wrong, and not so scientific as they think, who *deny* conciousness where it is not proved. Incipient stages of consciousness there must be. Yet we cannot know definitely where these beginnings are. And not only is the criterion defective on this side, but careful observation under all possible condi-

[1] Art. in *Pflügers Archiv*, 1898, pp. 19–23 particularly.
[2] *Ibid.*, 18.
[3] *Pflüger's Archiv*, Vol. LIX.

tions is required. It is not the customary and regular movements of micro-organisms, for example, that, according to this criterion, decide their capacity. It is rather the unusual and out of the way in movement, just what the biological student is most likely to miss, and, indeed, to think not worth looking for.

Even the simplest relation of consciousness to action in the particular case, moreover, as is evident, cannot be treated without reference to the relation between consciousness and animal movement in general. It is necessary to consider separately the mental character of the act and the possession of consciousness by the organism which acts. The one does not imply the other. Thus a secondary reflex act is mental in origin, while it is unaccompanied by consciousness. No kind or degree of complexity in reaction, so long as the phenomenon is simply different response to different stimulus, can prove the presence of consciousness; and even a change in response, if it is not sudden or transient, may arise from internal causes that we should call physiological rather than psychological. But it seems impossible satisfactorily to explain the *origin* of certain complex modes of reaction without bringing in consciousness. Its aid, in some other cases, too, we may believe would be an economy, since adaptations merely physiological are hardly capable of everything. There must be limitation somewhere from the nature of the physiological elements. All this means that not much reliance is to be had in negative conclusions drawn from the application of our criterion, whether they refer to a particular act, to an individual, or, as we shall see, to a race.

It is presumable that some adaptations which are strictly mental or conscious in origin have lost their conscious or mental character in the particular individual. Perfect adaptation to environment, through conforming all acts to absolute rules, would perhaps mean, in the simpler organisms, even the entire disappearance of consciousness. Some instincts seem to be sets of actions approximated to this character, and they may best be regarded as racial reflexes, so that an instinctive act need not involve the presence of mind or consciousness in the agent, though mind may have performed its function of adaptation in this matter and consciousness may then have disappeared. Indeed, Cope's position, perhaps not consistently held to, is that mind embraces "the unconscious derivatives of conscious antecedents."[1] Again he says: "Consciousness may be supposed to be necessary to the performance of an act which displays a definite relation to the satisfaction of some need of the animal, but such an act does not necessarily prove that consciousness is

[1] *Loc. cit.*, 900.

necessarily present at the moment of action."[1] And specialization of function, completed education, for him "means unconsciousness, while consciousness is necessary to the beginnings of education and its successive steps up to completion."[2] The possibility, therefore, is to be taken account of, that in lower organisms all mind may have passed into the reflex stage after adapting the species to its environment. So consciousness may have disappeared from species originally possessing it.

It would be desirable to formulate a definite criterion for the mental origin of organic movements. But general resemblance and connection by fine gradations with acts known to be conscious seem to be the best marks at present available. "Choice" in some sense may be the criterion here, but if so it has yet to be carefully defined and the mode of its application developed. The above quotation from Cope suggests a possibility in this direction. Romanes, also, says that indications of choice are indications of consciousness, but as reflexes have the same appearance, the test is whether the adjustments are invariably the same under the same circumstances of stimulation.[3] Thus Romanes himself seems to use the criterion of choice only for what, on one theory of reflexes, would be the remote effects of mentality on action, and in practice, learning by experience as a test for the presence of consciousness behind the particular act. In any case, the criterion at present sought is only to determine whether consciousness is now present in certain forms of life.

In considering protozoa in the light of the foregoing it is important to note that existing species could in nowise represent the first forms of life in respect of mentality. Protozoa are not proto-organisms in the sense of primitive or original forms of life, though they probably resemble these, in external attributes, more closely than does any metazoon. In fact, just in proportion as the *forms* of protozoa and their circumstances of life resemble those of the first forms of life, must the former depart from the latter, supposing the latter to have possessed the germs of consciousness in their psychology.

We are now in possession of what seems to be a definite criterion of mentality. Careful study of the movements of lower animals, with preconceptions such as those here combatted out of the way, should reveal something of their mental condition.

In the study of protozoa from a psychological point of view, although hardly anything can be more interesting and signifi-

[1] *Ibid.*, 901.
[2] *Ibid.*, 903.
[3] *Op. cit.*, 17.

cant, little has been accomplished, both because of inherent difficulty and because of biasing preconceptions. It is not the structure of protozoa, to which the zoölogist is almost exclusively attentive, nor even their regularly performed functions, more likely to be stereotyped in reflexes than to be conscious, that are of most importance from a psychological point of view. Hence the dearth of observations necessary to complete this Study.

M. Binet's little book is a convenient starting point in an examination of the facts bearing on the question before us. He finds plenty of evidence to show that at least some protozoa have something that corresponds to our sensations, especially touch, sight, and taste. He believes, also, that there is the capacity of localizing and even, in one species at least, the perception of position in tri-dimensional space.[1] Instincts he finds, in at least one case, of remarkable development.[2] These organisms spontaneously control many and complex motions. Preferences are shown for certain objects of food such as seem to involve degrees of pleasantness in gustatory sensations.[3] Similar seemingly affective preferences are exhibited by bacteria for certain colors of the spectrum.[4] Also, in some cases, moderate degrees of intensity of stimulation are sought, while greater intensities are fled from, so that the attraction here could not be merely physical.[5] On the whole, however, the evidence collected by Binet is in a confused state, and he seems unable to determine what is decided and what not.

Prof. Max Verworn has made a careful study of protozoa with

[1] *Op. cit.*, 53–4, 61, 63–4. J. Soury, in the *Revue philosophique*, Vol. XXXI, attacks Binet's book. He alleges (p. 37) incorrectness of observation in the case of *Diniduum Nasutum* cited. Soury offers no new evidence, and in theory is decidedly bad. He mixes Verworn's theory of consciousness with the belief in a thorough-going chemical physiology, and for the rest his work is characterized by multiplicity of "tropisms" and inconsistencies. In general, as regards the advocacy of tropism, it should be remembered that tropism at its best, *i. e.*, as mechanical attraction, should obey the law of inverse squares, proportional intensity, etc.

[2] *Ibid.*, p. VI. Questioned by Soury, *loc. cit.*, p. 38.

[3] Binet himself cites a different explanation by Maupas, *op. cit.*, 41, 45, 47, 62–3. The writer has hit upon the following, which supports Binet. "Although in two instances the animal [an Acinetan] was observed to capture ciliated Infusorians, its preference is decidedly for the Amœba, which are abundant in the aquarium referred to." C. C. Nutting, *American Naturalist*, Vol. XXII (1888), p. 14. Another series of observations indirectly significant is that of Metschnikoff, showing preference, by phagocytes, especially of dead to living tissue.

[4] Binet, pp. 33–4. Wundt also says: "The fact that even the protozoa congregate in light of one quality and avoid spots illuminated by that of another must depend on some original sensation character and pleasantness." (*Lectures*, trans., p. 348.)

[5] Binet, 34, and *cf.* 38.

reference to their psychology, and that without damaging preconceptions, though perhaps with the biologist's drawback of thought only for the regular functioning of these simple beings. His peculiar and questionable theory of self-consciousness, however, and his indefensible definition of consciousness according to which it involves self-consciousness,[1] make necessary a reconsideration of his conclusions. He finds that response to stimulus has a mechanical rapidity and sureness, and constancy of form.[2] He cites one instance of injurious tropism, but it is where the stimuli to that degree are not usual.[3] He concludes that stimulated movements are reflex, and spontaneous movements impulsive and automatic, in his own sense of the terms.[4] "Bewusste psychische Vorgänge in dem Sinne, wie wir sie als Gegensatz zu unbewussten bezeichnen, können bei Protisten noch nicht vorhanden sein," although the germ of consciousness is there,[5]—this in his own sense of conscious. The general drift of his observations would seem to point to the conclusion that the protozoan mind has passed into the reflex stage. Yet one cannot be too cautious in drawing fixed conclusions. No one would now-a-days deny consciousness to rats and mice. Yet a rat or mouse with hind feet cut off will go through the ineffective motions of scratching with them, all his life, without difference in frequency and vigor.[6]

One particularly noteworthy piece of evidence for consciousness in protozoa, moreover, deserves to be cited. Hodge and Aikins have made observations not only valuable for results, but quite as much so for method. Although the observation was made not for psychological purposes, the following is recorded: "We attempted to obviate this difficulty by sterilizing the water supply, and by boiling and covering antiseptically, at the same time giving in the place of their normal food a pure culture of yeast plants. This attempt resulted in an interesting demonstration of the educability of Vorticellæ. At first they took this, to them, newly discovered food with great avidity, filling their bodies to distension with food vacuoles of the yeast. In a very few minutes, however, the entire meal was ejected with volcanic energy. Not a single torula was allowed to remain in the body, and for several hours at least—how long the memory lasted was

[1] *Psychophysiologische Protistenstudien*, Jena, 1899, pp. 133-6, 143-5, *e. g.*

[2] *Ibid.*, 137.

[3] *Ibid.*, 139-40.

[4] *Ibid.*, 140-41. But *cf.* Cope's words, *loc. cit.*, 903: "All authorities agree that some of the actions of the Infusoria are in no sense automatic, but display a design as appropriate to the occasion as do those of the higher animals."

[5] *Ibid.*, 145-6.

[6] *Cf.* Romanes, *Darwin and after Darwin*, Vol. II, p. 80-81, ftn.

not determined—the individual could not be induced to repeat the experiment."[1]

It is true that this result stands alone, but the method of observing protozoa seems to be quite as much alone.[2] Such experimental variation of conditions with patient continuous observation and careful record, not merely of ordinary, but also of extraordinary occurrences, is just what is needed. It is not here the business of the scientific man to find a constant. It is from observations yet to be made that we may hope to learn something of the psychology of protozoa.

In conclusion, it must be admitted that this paper can at most only clear the way for observation that may lead to results. At present materials are inadequate, in respect both of quantity and kind.

---

[1] "Daily Life of a Protozoan," *American Journal of Psychology*, Vol. VI, p. 530.

[2] In a valuable paper, *The Psychology of a Protozoan*, in the *Am. Jr. of Psych.* for July, 1899, H. S. Jennings sets forth certain results obtained from careful study of the Paramecium. He finds it possible to explain by a single simple reflex reaction to stimulus, no matter what or where applied, all the seemingly complex psychical phenomena exhibited by this animal. The response he believes to be in exact analogy to the irritability exhibited by the isolated muscle of a frog. The significance of the character of stimuli, however, deserves emphasis. The fact of an optimal temperature and of reaction not in proportion to the intensity of stimulus cannot, at least, be explained mechanically. If Paramecia, moreover, gather "indifferently about loose fibrous bodies of any sort," there is a suggestion of something corresponding to the sensation of touch. These facts, it is true, may be called merely physiological; but who can distinguish the merely physiological from the degenerate mental? Does not this suggest the possibility that the physiologist has at least something to learn from psychology as well as from chemistry and physics? It is not the least merit of Dr. Jennings' paper that he attempts no mechanical explanation of the nature of protozoan activities. He would probably admit that it is only a figurative use of words when he speaks, at the conclusion of the article, of "the machine-like nature of its [the Paramecium's] activities." It is always proper to demand of the one who would explain everything mechanically that he *draft* his machine. Until he does this his task is incomplete. Incidentally the importance given to "learns nothing," in the concluding sentence, may be remarked, as showing what sort of evidence is sought.

PSYCHIC RUDIMENTS AND MORALITY.[1]

By GEORGE E. DAWSON.
Sometime Fellow in Psychology, Clark University.

OUTLINE.

§ 1. The Law of Differentiation.
§ 2. The Law of Elimination.
§ 3. Modes of Elimination.
§ 4. The Law of Persistence, and Arrested Development.
§ 5. Hypertrophy and Diseases due to Arrest.
§ 6. Prepotent Retrogression.
§ 7. Conclusions.

§ 1. THE LAW OF DIFFERENTIATION.

The first law of development, and one too well known to need elaborate illustration, is that of differentiation. Animal life begins with unicellular organisms, many of them less than a thousandth of an inch in diameter, and develops by proliferation of cells into all the diverse species of the animal series. The simpler Protozoa perform the functions necessary to their existence without specialized organs, moving from place to place, absorbing and assimilating their food and reproducing their kind by processes in which the whole body is involved. Among the Metazoa, these functions cease to be performed by the organism as a whole and are distributed more and more to specialized organs, until in the higher animals we find highly complex nutritive, reproductive, motor, and nervous systems.

The same law, of course, is operative also in the development of each individual. The human being begins life with a single cell something like the 125th of an inch in diameter. This cell divides and subdivides, until in the adult body we find 26,500 billion cells, built up into the vast variety of bodily organs. In this development of the individual, phylogenetic history is recapitulated. Each group of organs reveals, with varying

[1] I am under great obligations to the entire psychological faculty of Clark University for help in the preparation of this article. Especial acknowledgments are due to President Hall, who suggested the topic and supplied constant inspiration and guidance in working it out; to Professor E. C. Sanford, who gave valuable advice and assistance in the revision of manuscript; and to Mr. Louis N. Wilson, who helped me to procure books of reference not readily accessible.

degrees of distinctness, the process of differentiation from simple to complex types of organization.

The same law holds, moreover, for the mind as well as for the body. The different elements are more difficult to trace in their beginnings and development than are organic structures, but the general fact of their increase in complexity is clear. From the close relation of the instinct-feelings to the welfare of the organism, it might be inferred *a priori* that the same general law would operate in one case as in the other. Darwin apprehended this truth when he said:[1] "It will be universally admitted that instincts are as important as corporeal structures for the welfare of the species, under its present conditions of life. Under changed conditions of life, it is at least possible that slight modifications of instinct might be profitable for the species; and if it can be shown that instincts do vary ever so little, then I can see no difficulty in natural selection preserving and continually accumulating variations of instinct to any extent that was profitable. It is thus, as I believe, that all the most complex and wonderful instincts have originated."

Did space permit it would be easy to show this growing complexity of the psychic life by abundant citations, but the point is not one that is likely to be contested.

§ 2. The Law of Elimination.

Differentiation is only the positive aspect of development. There is also a negative aspect, illustrated in the correlative process of elimination. As life is brought into more complex relations with environment, it requires new organs to mediate its functions. Meanwhile old organs cease to be serviceable and fall into disuse. When vertebrate animals began to leave the water they were unable to breathe air by means of gills. Accordingly, their change of habitat involved the development of lungs, and the gills fell into disuse. Again, when vertebrate animals took an upright position and commenced to walk upon two legs instead of upon four, various modifications became necessary. The triradiate pelvis would not support the viscera adequately; the keel-shaped thorax would not accommodate itself to an upright position or admit of the freedom of movement in the fore-limbs that was necessary; and the whole complex of muscular structures was out of adjustment. Accordingly, the transition from a horizontal to a vertical position of the body involved an expansion of the pelvis, a flattening of the thorax, and a readjustment of the muscles; and these changes rendered certain organs like the sternal ribs and various muscles functionless for their original purpose. Function-

[1] *Origin of Species:* Vol. I., p. 321.

less organs are also found in psychical development. When animals became terrestrial a vast complex of new instincts had to be formed, and a corresponding complex of instincts that served the ends of aquatic life fell into disuse. Every stage in the advancement of mankind, from a life dependent upon the chase to that dependent upon agriculture and other settled industries, has involved new instincts and types of intelligence, and the disuse of old ones.

The elimination of all such functionless organs, psychical as well as physical, has therefore been as necessary in the economy of Nature as has been the differentiation of new ones. The two processes are everywhere concomitant. But elimination is slowly accomplished. The useless organ yields by degrees, and often persists in the midst of environments that are vastly more complex than those in which it normally functioned. Everywhere in nature rudimentary and aborted organs point to a past inconceivably remote. These it is that establish the law of elimination, inasmuch as they are clearly undergoing regressive change. The nature of such rudimentary organs has been defined by Wiedersheim as follows:[1] "By such organs are meant those which were formerly of greater physiological significance than at present. In the course of generations, in consequence of the adaptation of the body to special conditions of life, they have been, so to speak, put out of the running, subjected to reduction or degeneration, and now persist as mere vestiges." The law of elimination illustrated in such a reduction of structures is thus stated by Darwin: "It appears probable that disuse has been the main agent in rendering organs rudimentary. It would at first lead by slow steps to the more complete reduction of a part, until at last it became rudimentary, as in the case of the eyes of animals inhabiting dark caverns, and of the wings of birds inhabiting oceanic islands, which have seldom been forced by beasts of prey to take flight, and have ultimately lost the power of flying. Again, an organ useful under certain conditions might become injurious under others, as with the wings of beetles living on small and exposed islands; and in this case natural selection will have aided in reducing the organ, until it was rendered harmless and rudimentary."[2] Such evidence of the action of the law of elimination, to speak first of the physical organs, is found in bewildering abundance when search is made for it, and that not only in plants and animals, but in man himself. In his case embryology and comparative anatomy have accumulated a mass of data as

[1] *Structure of Man*, p. 2.
[2] *The Descent of Man*, p. 401.

astonishing as they are conclusive. Wiedersheim[1] enumerates more than a hundred structures and groups of structures that are either regressive or shifting in position. Many of the groups, moreover, include a large number of individual organs, as, for example, the muscular groups. Now, if one can imagine each of these structures and groups of structures to be fully developed organs, instead of more or less unobtrusive rudiments, he will have before him a type of what the human body would be had not the economies of nature been so administered as to eliminate the useless.

Psychic rudiments have thus far received comparatively little attention from psychologists. They are, however, as much a logical corollary of the theory of evolution as are the regressive structures in the physical organism. The doctrine of the latter, before the time of von Baer, was largely an inference awaiting proof or disproof. As has already been seen, it is now as well established as any other law of comparative anatomy and embryology. Darwin recognized the existence of the parallel psychical law. Thus, in speaking of regression in relation to moral qualities, he says:[2] "Some elimination of the worst dispositions is always in progress, even in the most civilized nations. Malefactors are executed or imprisoned for long periods, so that they cannot freely transmit their bad qualities. Melancholic or insane persons are confined or commit suicide. Violent or quarrelsome men often come to a bloody end. . . . Intemperance is so highly destructive that the expectation of life of the intemperate, at the age of thirty, for instance, is only 13.8 years; while for the rural laborers of England at the same age, it is 40.59 years. Profligate women bear few children, and profligate men rarely marry; both suffer from disease. . . . With mankind, some of the worst dispositions, which occasionally without any assignable cause make their appearance in families, may perhaps be reversions to a savage state, from which we are not removed by very many generations." A like recognition of the paleogenetic origin of many psychical attributes that are now discordant factors in civilization would probably be accorded by most comparative psychologists. But the idea of deriving the present psyche from a more primitive one has not found such definite expression in psychological literature as has the correlative idea of organic derivation in the literature of comparative anatomy.[3]

---

[1] *Structure of Man.* This work may be consulted for abundant confirmation of the law under discussion. See also §§ 4, 5 and 6 of this article.

[2] *Descent of Man*, p. 153.

[3] Recently, however, Pres. Hall has made full use of this idea in the analysis of a group of instinct feelings (*cf.*, A Study of Fears. *Amer-*

§ 3. Modes of Elimination.

Granted the general operation of the Law of Elimination the next question is as to the methods by which elimination is accomplished. There are three principles which are deducible from the phenomena of regressive transformation in organic and psychical life:

1. *The process of elimination is slow.* Nature does not abruptly extirpate an organ as soon as the conditions that brought it into being and made it serviceable have passed away. When the fishes of Mammoth Cave found their present habitat in subterranean waters, they undoubtedly had eyes like those of other fishes. These eyes, however, must soon have become functionless. Now, hundreds of generations of such animals have come and gone, each living in total darkness. Yet the work of eliminating the functionless structures of sight is not completed; rudiments of eyes still appear, recalling the far-off ancestors that disported themselves in sun-lit waters. Darwin says in regard to the gradual processes of Nature in this respect:[1] "It may be doubted whether a change of structure so abrupt as the sudden loss of an organ would ever be of service to a species in a state of nature, for the conditions to which all organisms are closely adapted change slowly. Even if an organ did suddenly disappear in some one individual by an arrest of development, inter-crossing with the other individuals of the same species would tend to cause its partial reappearance, so that its final reduction could only be effected by some other means."[2]

Psychical elimination is also slowly effected. This is shown in the feral instincts and habits of domestic animals, which persist hundreds and it may be thousands of years after they have ceased to be functional in a strictly economical sense. Among men, the same feral psychoses, with their fondness for strange foods and primitive ways of securing them; their uneconomical and dangerous sex proclivities; their multitudes of fears of animals, men, and other objects; their superstitious beliefs about dreams, ghosts, and celestial phenomena; and their sinister passions of anger, jealousy, envy, and oppression, indicate the inertia of the human soul and its resistance to radical processes of change. No one that has studied history and current civilization, or the phenomena of ontogenetic growth as revealed in himself and others, can be ignorant of

ican Journal of Psychology, Vol. VIII [1897], pp. 147–249), and has been followed in it by several of his pupils

[1] *Plants and Animals under Domestication*. Vol. II, p. 308.

[2] *Cf.* a remark on the excessive slowness of organic change, by Weissmann. *The Monist*, Vol. VI, p. 255.

the tremendous truth that Nature is on the side of the best aspirations and the best efforts of the race. But, as Nature has reduced the number of superfluous ribs only by a process extending over hundreds of centuries, so must the forces that make for psychical evolution gradually effect those variations which shall adapt men to the conditions of a more complete existence.

2. *Elimination is effected through the atrophy of structures or qualities.* This is the usual method in organic variations. Disuse normally leads to regressive change in tissues, since the metabolic processes are interfered with by any decrease in the functional activity of organs. Psychical atrophy is illustrated in the disappearance of instincts and habits. All the domestic animals must at one time have been more or less migratory, yet the instinct has now disappeared in most cases. The same may be said of their fear of man. In fact, every young animal in a state of domestication recapitulates the process of taming that its species has undergone at the hands of man, and this recapitulation is a kind of ontogenetic atrophy by which the resurgent instincts are again reduced.

In man, there can be no doubt that, grossly considered, all the instinct-feelings have been modified in the direction of less intensity. The appetite for food is not so voracious among men as it is among animals, and not so voracious among civilized peoples as it is among savages. The same is true of the sex-instinct. Among the lower races the latter is much stronger than it is among the higher races. This is especially true in the case of women. Both on anatomical grounds, and for psychical reasons as well, the female savage is more erotic than her civilized sister, as the investigations of anthropologists have shown. The fear and anger psychoses have also been greatly reduced as a whole, as have the related malevolent instincts. What is true of the race is more especially true of individuals. In many men and women, it must be owned by the most pessimistic that the food and sex instincts are entirely under control. Temperance in the one and continence in the other are realized facts, life being practically emancipated from the bondage to those appetites. In many individuals, also, atrophy of the cruder fears and the more malevolent passions has advanced so far that these qualities are rendered harmless. The fact that such transformations are so nearly completed in some individuals of the race points the course of evolution, for general progress first comes to light through sporadic variations.

3. *Elimination is sometimes effected through transformation of function.* Darwin says:[1] "An organ may become rudimen-

[1] *Origin of Species*, Vol. II, p. 257.

tary for its proper purpose and be used for a distinct one. In certain fishes the swim-bladder seems to be rudimentary for its proper function, but has been converted into a nascent breathing organ or lung. Many similar instances could be given." The transformation of function becomes possible through the fact that an organ commonly has not one function but a number of functions to perform, of which functions one is predominant at any given moment, and the rest are subordinate. "Each function is a resultant of several components of which one is the principal or primary function, the other secondary. Diminution of the primary function and increase of a secondary function alters the total function; the secondary gradually becomes the primary, the total function is changed, and the issue of the whole process is the transformation of the organ."[1]

There are many illustrations of this principle in organic development. Man's arms illustrate a change in function from locomotion to their present uses. The teeth of various animals, which were once used as a means of defense, have been modified and adapted to purposes of mastication. The human tongue, which originally functioned as an organ of alimentation, is now also an organ of speech. This is perhaps the nearest approach in nature to a transformation from physiological to psychical functions.

On the psychical side, we find illustrations of change in function in the sex-diathesis. The entire group of courting instincts have been progressively modified in the direction of conjugal, parental, and social instincts. In the very lowest animals union of the sexes and the deposition of eggs summed up the phenomena of reproduction. Then came the love of offspring, which has since been transformed through countless differentiations into life-long affection and care, not only for one's own children but also for the children of others. The transformation of a desire for union with the opposite sex into conjugal feeling was more slowly, though not less surely, accomplished. At first, sexual relations were possibly indiscriminate; then they were modified by temporary associations of the sexes; then by polygamous marriages, which made such associations more or less permanent; and finally, by monogamous marriages, whose ideal is expressed in the marriage rituals of Christianity, binding the sexes together in "holy wedlock" as long as life shall last. Illustrations of sex transformations are numerous among the individuals of every civilized community. Boys, who in adolescence recapitulate the sexual instincts of their phylum, find the sex yearnings of mature life satisfied by the chastest of companionships with

[1] Marshall: *Biological Lectures and Addresses*, p. 59.

women, and by such sexual amenities as politeness and deference to every woman they meet. Girls in whom conjugal and maternal instincts are rife during early womanhood become women whose sex yearnings are satisfied by intellectual companionships, or by labors of love among the children of other women,

The transformation of fears is not less remarkable. Among animals, fright, terror, timidity, dread, and distrust are everywhere powerful emotions. In man, these become transformed into caution, respect, bashfulness, awe, and reverence. Similarly rage, hatred, revenge, etc., have more and more yielded to altruistic forms of indignation. While even jealousy and envy may be transformed into a spirit of emulation that is healthy and economical when the ends to be secured are worthy.

§ 4. The Law of Persistence and Arrested Development.

The Law of Persistence is the natural antithesis of the Law of Elimination. The process of elimination that normally accompanies development is sometimes retarded or arrested. The struggle for existence is nowhere more rigorous than among the structures of the body and the attributes of the soul. Matter is inert and resists the organizing force that elaborates it into higher and higher forms. It is always seeking lower levels of organization, and, unless the circumstances are favorable, creative energy is overcome and development becomes retrogressive. Psychical evolution is not less difficult. There is an inertia of soul as well as of body. Even under normal conditions the pull downward is only a trifle less strong than the push upward, and this unstable condition is always in danger of being inverted. It would seem that in the world of mind as in the world of matter "there is a tendency for energy to pass from the higher or more readily transformable to the lower or less readily transformable forms." Low potential existence is easy; high potential existence is difficult.

Let us come to closer quarters with the facts.[1] The tendency of life to seek lower levels is shown first in the reappearance of structures and types peculiar to lower developmental stages. This results proximately from the fact that ontogenetic devel-

[1] The same set of facts shows the operation of both the Law of Elimination and that of Persistence; a rudimentary organ is evidence of the process of elimination in that it is rudimentary and of the tendency to persist in that it exists at all. The facts enumerated in the following sections will therefore serve as evidence for the truth of both principles, and make up in part for the meagerness of citations in the previous sections.

opment is recapitulatory. Each individual passes through the stages through which its phylum has passed. If for any reason, therefore, development is arrested at a point corresponding to one of these lower stages, the qualities characterizing the latter will persist. We have here to distinguish between growth and development. *Growth* results from the augmentation of each of the parts of a body, independent of all change in their number, structure, or functions; *development*, on the contrary, consists of differentiation of the organism into a greater number of structures and into greater complexity of structures and functions. The two processes, while normally correlated, may take place more or less independently. Thus, if a tadpole is kept excluded from light and heat, but at the same time is supplied with food, it may *grow* into a gigantic tadpole, but never *develop* into a frog. This is what is meant by "arrest of development;" there has been simply augmentation of the parts of the tadpole's body without any change in their number, structure or functions. In other words, the enlarged tadpole is just as homogeneous as the small one. Thus, arrested development renders persistent the peculiarities of the stage at which it takes place, while the augmentation of these qualities through continued growth throws them into greater and greater prominence.

1. *Organic Arrests.* The structures of the human body that are normally vestigial, and appear only at certain stages in the development of the embryo, sometimes become persistent. (1) The *branchial sacs* found in the embryo, occasionally persist into adult life, penetrating the anterior cervical region and even opening into the pharynx. Fisher[1] found that in sixty-five persons thus affected there were 79 clefts, 51 being unilateral, and 14 bilateral. Twenty cases opened into the pharynx, and 53 did not. There were thirty-four males showing this anomaly and thirty females, and there was evidence of heredity in twenty-one cases. (2) The human embryo during the early part of its development is bisexual, having both the male and female genital ducts. At this stage, it resembles hermaphrodite forms of life. Later, the paired Müllerian ducts develop into the female genital system, and the Wolffian into the male genital system. Sometimes the early embryonic condition persists and grows into a more or less perfectly developed bisexual system. The result is human *hermaphroditism*. (3) At one stage in the development of the Müllerian ducts in the female, they are separated throughout after the manner of didelphous animals. Not infrequently this didelphous condition persists, and

[1] Quoted by Bateson: *Materials for the Study of Variation*, p. 175.

the result is the abnormal forms of uterus, such as *uterus duplex*, *bilocularis*, *subseptus*, *bipartitus*, *bicornis*, etc. (4) At an early stage of embryonic life, there appears a free projecting appendage joined to the caudal vertebræ and resembling a tail. In time, this appendage normally becomes absorbed, and when the child is born no trace of the tail is left except the *vertex coccygeus*. But sometimes this absorption does not take place, and the tail persists into adult life. From the middle third of the present century, thirty well-authenticated cases have been recorded among civilized peoples. Thus Shaeffer mentions four cases of caudal formation, associated with other anomalies. Raband[1] reports the case of a boy who had a tail nearly a foot long. Wiedersheim[2] cites several cases: one, recorded by Gerlach, of an embryo with a true caudal appendage one-sixth of its length; and one, recorded by Lissner, of a female child that had a tail containing an axial continuation of the vertebral column. Kögel,[3] Schultze,[4] Freund,[5] and others state that these anomalies are common in Borneo, the Sunda Islands, and various places. (5) During the sixth month of its life, the human fœtus is entirely covered with a coat of soft hair called the *lanugo*. Normally, this lanugo marks only a recapitulary stage in the development of the corneous structures. Through an arrest of development, however, the fœtal hair may persist and grow into a permanent hairy covering. Wiedersheim mentions the Ambraser family, Barbara Uslerin, Julia Pastrana, the Russian "dog-man" Jeftichjeff, his son Fedor, and the Burmese Shewé-maong and his family. Of these, Jeftichjeff and Shewé-maong had the whole face thickly covered with delicate soft hair. The Russian's body was less hairy than that of the Burmese, which was entirely covered with hair from four to eight inches long. Flesch[6] describes a boy 2¾ years old, who was a light blonde in complexion and had a growth of hair upon either cheek. This hair was from 1.5 to 2 cms. long and very light in color. There was also a heavy growth of hair on the breast, shoulders, and back; this was thick, and 2.5 cms. in length. Stricker[7] describes a girl who lived in Augsburg during the 17th century. This girl was covered with a very fine silky white hair, and had a rather heavy beard of the same color and texture. Morgan[8] men-

[1] *British Medical Review*, August, 1891.
[2] *Structure of Man*, p. 29.
[3] *Globus*, Vol. XXXI, No. 5.
[4] *Zeitschrift für Ethnologie*, Vol. IX.
[5] *Virchow's Archiv*, Vol. CIV, p. 531.
[6] *Archiv für Anthropologie*, Vol. XIII.
[7] *Virchow's Archiv*, Vol. LXXI, p. 111.
[8] *British Medical Review*, July, 1891.

tions a tuft of hair in the middle of a boy's forehead, evidently hereditary, as it could be traced through four generations. This anomaly recalls a similar tuft of hair found on the head of the gorilla. (6) Another example of the persistence of a tegumentary rudiment is probably found in the disease called *ichthyosis*. This disease consists of a thickness of the whole skin in more or less regularly shaped scales. It is not well understood, but is known to be hereditary. It is not unlikely that it represents in a hypertrophied form the *stratum corneum* of the embryonic period, rendered persistent through an arrest of development at the epitrichial stage of the corneous structures. Very similar is the anomaly described by the writer of "Vestiges of the Natural History of Creation,"[1]—that of an Englishman who had semi-horny excrescences a half-inch long growing thickly all over his body. This anomaly was hereditary also, being traceable through three generations. (7) It seems probable that the brains of microcephalic idiots and some species of imbeciles represent exaggerations of rudimentary types of structure. Cunningham,[2] who studied the brains of two microcephalic idiots and compared them point by point with the brains of different species of monkeys, obtained the following results: (a) In general, the peculiarities group themselves according to three types—that of the higher apes, that of the lower apes, and that of quadrupeds. (b) The relation between the weight of the cerebrum and that of the cerebellum is similar to that found among quadrupeds. (c) The arrangement of convolutions in one of the brains is more ape-like than human. (d) A number of sulci and gyri are similar to those of apes. And (e) there is a marked reduction of that part of the hemisphere which lies behind the fissure of Rolando. Mickle gives the following variations in the parieto-occipital fissure, each of which is present in certain ape forms, some microcepheles, and some fœtuses: (a) An internal limb of parieto-occipital fissure interrupted by a superficial *gyrus cunei*, or other annectant gyri, which has attained the surface. (b) Doubling of the internal limb of the fissure, shortness of it, failure to reach the upper border, slightness of its incision there. (c) Its defective depth and boldness relatively to the calcarine. (d) Spurs running fore and aft from the internal parieto-occipital limb, furrowing and practically expending themselves on præcuneal surfaces, or shallowly touching the upper hemispheral edge. (e) Confluence of the conjoint "stem" of calcarine and parieto-occipital with col-

[1] Anonymous. But a pioneer work in literature of evolution. Published in 1852, at Cincinnati.

[2] *Journal of Medical Science*, Vol. XLII, p. 541.

lateral fissure. On the side of more minute anatomy, Bevan Lewis[1] has found in the brains of epileptic idiots a type of cells that normally appear in the cortex of the apes. These are the inflated spheroidal cells that are distinguished, not only for their peculiarity of contour and nuclear structure, but also for the paucity of their branches.

2. *Psychical Arrests.* The general type of arrested psychical development is the *idiot.* All classes of idiots illustrate the persistence of qualities found among animals, but usually appearing only in the lowest developmental stages of man. Their intelligence is feeble, they are incapable of attention, and they are extremely imitative. In the microcephalic type they are unable to speak, and are fond of gambolling about on all fours, running up stairs, climbing trees, etc.[2] Several cases are recorded where they smelled every morsel of food before eating, and one idiot used his mouth in hunting lice from his body. They are usually filthy in their habits, and have no sense of decency. Hunger is little inhibited, and usually leads to gluttony. The sexual instincts are uncontrolled when present. Masturbation is exceedingly common among all idiots of both sexes. Onanism, sodomy, and various other sexual psychopathies of a revolting nature are practiced by some in whom there is strong sexual desire united with an absence of moral perception. Destructive tendencies are common, the lower grades destroying through carelessness, but the higher grades often showing a malicious satisfaction in inflicting damage or injury. An inclination towards homicide, arson, etc., is not uncommon. Fear is often exaggerated, the simplest causes producing great excitement. Anger is manifested without reason, and is paroxysmal in character, leading to the infliction of injuries upon the individual himself, or upon other persons and inanimate objects.[3]

Arrest of psychical development may be illustrated more in particular by vagrancy, pauperism, theft, gluttony, drunkenness, unchastity and assault.

(a) *Vagrancy* and *pauperism* represent the persistence of the unproductive food-appetites found in animals, children and savages. The vagrant and pauper are social parasites par excellence. Many causes operate to produce such individuals, but incapacity to adapt themselves to social and economical conditions that oblige every man to work for a living is one of the most important. Cast little children adrift in the world and they will be helpless. Place men and women of the lower races

[1] *A Text-book of Mental Diseases*, p. 527.
[2] Darwin: *Descent of Man*, p. 52.
[3] Peterson: The Psychology of the Idiot (*Am. Journal of Insanity*), Vol. LIII, 1896-97, pp. 1-25.

in the midst of a civilized community and they will be almost as helpless as the children. Nor will this be altogether due to the disadvantages arising from changed environment; it will be due, in a large measure, to their incapacity for settled modes of life and routine occupation. This has been illustrated in the American Indians, who were brought within the influence of civilization by the incursions of Anglo-Saxon peoples. Few of the Indians have ever learned to work. As soon as the natural means of subsistence were exhausted they depended upon the government for support. Except as the wards of the white people who have appropriated their domains they could not now exist in many sections of the United States. A handful of Sioux Indians would starve to death without government supplies upon a reservation that would support in affluence a population of Anglo-Saxons ten times as numerous. A similar illustration is afforded by the Negroes. The native Africans are generally children of Nature, making very little effort to improve upon her methods of support. When they were imported to the United States and placed under white taskmasters they were obliged to work somewhat after the manner of the civilization surrounding them. But after they became their own masters and took their places as self-supporting members of a free society, the race instinct of carelessness and improvidence asserted itself. Many of the best men and women among them have indeed proved their fitness to survive by adjusting themselves to the conditions of free competition. But the great majority of them have not been able to do so, and will not be able to do so for centuries. It is not accidental that so many negroes like to sun themselves in the streets of southern towns and cities, or that throughout the country everywhere they so often content themselves with some chance means of subsistence, such as cleaning out ash-pits, laying carpets, blacking boots, running elevators, etc. While few negroes become vagrants or paupers in the strict sense of such terms, many of the race are satisfied to live in a manner that insures immunity from pauperism and vagrancy rather through an absence of wants than through an ability to supply them.

The general unadaptiveness of such primitive peoples to the economical conditions of civilization is reproduced in some men and women of the highest races. Their development has been arrested at a point corresponding to the improvident stage of appetite. In every civilized community there may be found those incapable of supporting themselves by regular employment. Such are the tramps and strolling vagabonds of every description, and such are most of the professional beggars and many of the pauper class. The statistics regarding such elements of society are extremely incomplete. Thousands of them

manage to keep out of the hands of the law through some makeshift of wit. But we know they are everywhere. According to the Poor Law statistics of Great Britain for 1880, there were at that time in England and Wales 5,914 vagrants, and 808,030 paupers. In France, among the prisoners sentenced in 1882, 23 per cent. of the males and 20.5 per cent. of the females were committed for vagrancy and mendicity. In Switzerland, during the years 1870–74, 4.6 per cent. of the delinquents were vagrants. According to the United States census for 1890, there were at that time in public institutions of this country 2,843 adult vagrants, 1,336 juvenile vagrants, and 73,045 paupers, or 1,166 to every million of the population. While it would be incorrect to say that all these individuals are incapables from the standpoint of modern civilization, it is doubtless true that a large per cent. of them represent the type of arrested development here considered. It is the conclusion of M. Mounod, who investigated a large number of vagrants, that not more than one in forty would accept work if he could get it. This estimate would probably apply to the ubiquitous tramp of the United States.

Since all children pass through this stage of development, bad surroundings or disease often cause an arrest of development in those whom a bad heredity has not incapacitated already. From one or the other of these causes, boys and youth in comparatively large numbers go forth from every city and large town to swell the ranks of the parasitic classes. We find them in the truant schools, where they are sent because they will not, or cannot, adapt themselves to the conditions accepted by normal children. Later, the more pronounced cases of truancy may be found in the juvenile reformatories, where they have been sent for vagrancy or some other offense reducible to a general incapacity to discharge the duties imposed upon them by parents or society. Thus, L., aged 12, was a stubborn, intractable boy who did not like to do any kind of work. He would run away from home and be lost sight of for several days or weeks. At last, his parents invoked the aid of the authorities and he was placed in custody for a time. As soon as he was released, however, he ran away from home and was gone for a year. Then he was returned by a benevolent society which had discovered him in a New York hospital, and was again given a trial at home. But he ran away once more, was captured by the police, and sent to a reform school. H., a boy of 14, was the son of pauper parents, was himself in an almshouse for several years, and was finally given to a farmer to bring up. He was a born vagrant, however, could not be brought to a settled occupation, and at last became so incorrigible that he was sent to a reformatory. C., a boy of 16, was

vagrant in his disposition from childhood. He ran away to sea several times and gave his parents so much trouble that they complained against him, and he was commited to a reform school. After a term of probation there he was placed upon a farm, but immediately ran away, made his way to Europe and was gone a year. Then he returned and became a vagrant, but was arrested and returned to the reform school. N., a girl aged 16, was of pauper stock represented in the Pembroke (Mass.) almshouse for the last sixty years. Was herself placed in an almshouse at 13, and has since been in state institutions. Was utterly incapable of consecutive work and was indolent and improvident. P., a girl of 16, was born of improvident parents who could not support their own children. Was placed in a charitable institution, but later found a home in a private family. Became vagrant and wayward, however; had an illegitimate child, and was finally sent to a reformatory.

With all these cases, the primary difficulty was an inability or unwillingness to adapt themselves to the restraints of home and society, and to resist the impulses towards an irresponsible wandering about and loafing.

(b) *Theft* represents the persistence of the predatory instinct. The thief has first of all a defective moral sense, but more particularly a defective sense of the rights that inhere in property. Concomitant with these defects, is a disposition to idleness, vanity, and general self-indulgence. The qualities constituting the diathesis of theft are therefore very primitive. Some of them are found in animals, others are especially characteristic of savage and semi-civilized peoples, while most of them are recapitulated in the life of very young children. They are all characteristic of stages of development wherein rights of property have not come to be recognized, and wherein the inhibitory influences of morality and intellectual prevision have not yet become strong enough to check the impulses towards self-gratification.

Animals have no sense of property. They plunder from one another indiscriminately. It is only in such higher animals as the dog that we begin to see a certain respect for property rights, so far as they pertain to the master. Savages have a sense of property only a little more fully developed. The rights of ownership are but slightly regarded. They appropriate what they want, and protect themselves from one another in a manner analogous to that of animals. The ancient Aztecs of Peru and Mexico preserved their property from pillage by collecting it in large huts, which they closely guarded. In Egypt, the government granted licenses to robbers, the only recourse of the people plundered being to purchase back their property. Even after a certain family and

tribal sense of property had been developed, the disposition to steal from strangers had full sway. The Spartans allowed theft and punished a captured thief, not for his offense, but because he was not adroit enough to keep from being caught. The early Germans taught their youth to plunder from neighboring tribes. According to Thucydides, the Greeks and all the barbarians of the islands and sea coasts practiced piracy, for glory as well as for booty. In eastern Africa, those who are expert in pillaging from neighboring villages enjoy general esteem. The Esquimaux are honest in dealing with one another, but never with strangers.[1] As is well known, children have no sense of property at first. They take one another's playthings and sweetmeats, and there is nothing safe from their ravages, from pantry to orchard. This disposition to appropriate other people's property yields but slowly as childhood advances. Little girls will pick up toys and bits of finery at neighboring houses, while boys will extend their depredations to the various fruit and game preserves of the entire community.

Now, stop the development of the child at this stage when he is living over the instincts and habits of his animal and subhuman ancestors, and you will have a type of the most numerous class of moral delinquents of which the law takes cognizance. The property sense, which in civilized communities is so indispensable, has been one of the most difficult to develop; and the correlated instincts of idleness and self-indulgence are constantly reinforcing the impulse to steal. In Italy, from 1880 to 1884, there were yearly 221 trials for theft to every 100,000 of the population; in France, from 1879 to 1883, there were 121; in Belgium, from 1876 to 1880, there were 143; in Germany, from 1882 to 1883, there were 262; in England, from 1880 to 1884, there were 289; in Ireland, from 1880 to 1884, there were 101; in Hungary, from 1876 to 1880, there were 82; in Spain, from 1883 to 1884, there were 74.[2] During the year 1882, 66 per cent. of the commitments to prison in France were for theft, in the case of male delinquents, while in the case of female delinquents, 52 per cent. were for theft. In Switzerland, from the year 1870 to the year 1874, over 70 per cent. of the commitments were for theft.[3] According to the United States census for 1890, 44 per cent, of the inmates of penal institutions in this country were confined for theft of some kind.

The following illustrations of the forms this kind of arrested development may take are drawn from a typical community:

[1] Lombroso: *L'Homme Criminel*, pp. 65–68.
[2] Morrison: *Crime and its Causes*, p. 129.
[3] Ferri: *Criminal Sociology*, p. 33.

D., a boy of 15, was idle and vagabondish in disposition. His parents could not keep him in school or at work of any kind. He acquired the habits of smoking cigarettes, drinking, and going to the theater. His parents would allow him no money for such indulgences, and he took to stealing. At first he "sneaked" cigarettes, bottles of beer, etc., from the stores, then he stole money from cash drawers, and finally he stole a horse, sold it in a neighboring town, and squandered the money in drinking and going to the theater. For this he was committed to a reformatory. M. and J., aged respectively, 14 and 12, formed the habits of running the streets and smoking cigarettes. Their parents tried to correct them, and refused them spending money. They began to steal small sums from their parents, then from the neighbors and from cash drawers in stores; then organized a band of twelve boys and systematically looted tobacco stores for a year, dividing the booty and pledging one another to secrecy. At last they were detected in the act of burglarizing a store, and were sent to a reformatory. T., a boy of 18, well connected and holding prominent social and business positions, began to lead a fast life. His expenses for clothing, theatricals and card parties exceeded his income, and he began to forge checks and otherwise obtain money under false pretences. He squandered the funds of a Sunday school class of which he was the treasurer, signed his teacher's name to a check, operated more and more extensively in false signatures until he was guilty to the extent of several hundred dollars. Two sisters, aged 17 and 12 respectively, were fond of finery, and began to steal articles of jewelry, ribbons, etc., from friends. Then they took to shop-lifting, and operated in several stores for some months before they were detected. When arrested they had secreted in different places dress-patterns, pieces of silk, gloves, capes, jackets, table linen, thread, shoes, hats, diamond rings, etc. L., a girl of 18, well connected, but too fond of dress for her means, entered a flat by means of false keys she had secured, and stole a gold watch, a pearl ring, two pairs of gold earrings, two plain gold rings, and $75 in cash. With the money she purchased a silk sacque, a silk skirt and a pair of shoes, and then arrayed herself in all her stolen finery and started forth for a good time. These cases of theft, like all other forms of crime, are much too complex to explain upon any single hypothesis. But that defective development of the moral sense, and particularly of the sense of property rights, as well as a lack of the inhibitory impulses normally present in individuals at such periods of life, are central causes, cannot be doubted.

(c) *Gluttony* and *drunkenness* represent the persistence of the undiscriminating food appetite found in animals, savages and young children. Animals eat to repletion, and are often greedy to

a gluttonous extent. The ravenous appetites of certain of the Carnivora, and the omnivorous, perfectly insatiable appetites of the pigs are illustrative. Savages are enormous eaters, as is shown by the great development of their alimentary systems as well as by the amount of food they can consume. Their teeth and the bones and muscles of their jaws are larger and stronger than is the case among civilized peoples. Their stomachs are large and protuberant. The Kamschadales have a hanging belly. The Bushmen, according to Barrow, have uncommonly protuberant stomachs. Schweinfurth describes the Akkas as having "large, bloated bellies, and short, bandy legs." The children of savages are peculiarly developed in this respect. Those of the Veddahs and African Arabs have protuberant, pendant bellies. Galton says of the Damara children that "all have dreadfully swelled stomachs." The quantity of food eaten also bears a strict relation to the generous alimentary provisions for it. "Wrangle says each of the Yakuts ate in a day six times as many fish as he could eat." "Cochrane describes a five-year-old child of this race as devouring three candles, several pounds of sour frozen butter, and a large piece of yellow soap; and adds: 'I have repeatedly seen a Yakut or a Tongouse devour forty pounds of meat in a day.'" "Of the Comanches, Schoolcraft says: 'After long abstinence they eat voraciously and without apparent inconvenience.'" "Thompson says of the Bushmen that they have 'powers of stomach similar to the beasts of prey, both in voracity and in supporting hunger.'"[1] The children of civilized peoples have appetites very similar to those described. They eat to repletion and undiscriminatingly, and it is well known that this voracity of appetite accounts for many of the diseases peculiar to childhood.

Among adult men and women of civilized communities, the tendency to gormandize is not uncommon. "When we know how little food is really required to sustain life, we may the more readily surmise how very much more food is taken by most persons than can ever be applied usefully towards sustainment. We have no compunction in asserting that while fasting enthusiasts are subjecting themselves to considerable danger from abstinence, hundreds of thousands of persons are subjecting themselves to a slower but equal danger from excesses of foods and drinks. These keep up their experiment, and, with every vessel in their bodies strained to repletion and seriously overtaxed, continue to replete and strain the more."[2] Occasionally, individuals so distinguish themselves for the amount of food devoured that their cases are recorded in his-

[1] Spencer: *Principles of Sociology*, Vol. I, p. 45.
[2] Richardson, in *Tuke's Dict. of Psy. Med.*, p. 773.

tory. A Tartar courier is described by Vambéry as eating at one time a large skinful of raisins and a middle-sized pig, leaving nothing but the bristles and a few of the larger bones. At another time, within fifty hours, he ate a goat and two kids, together with a bag of dried figs and a quantity of koumiss. An Englishman, living in Yorkshire, exhibited himself as a professional glutton. He could eat a dozen pigeons, feathers, bones and all, and swallow trout and other fish alive. On one occasion he won a wager by devouring within two hours all the edibles, including half a cheese and a large quantity of pickles, on a table that had been set for eight persons.[1] As we know from history, some of the Roman emperors during the decadence of the empire were addicted to indescribable excesses of appetite. The feasts of Appricius lasted for a whole day, and sometimes for two days. Guests were restricted to recesses of ten minutes, and were obliged to eat something of everything placed before them and to drink a prescribed amount of wine. Vitellius ate three brace of peacocks at one sitting, prolonged his banquets hour after hour without intermission, and spent the revenues of an entire province upon one such debauch. Cicero describes the scene after a Roman banquet as resembling a battlefield. In the reigns of Caligula, Domitian, and Heliogabalus, such occasions were the financial ruin of the wealthiest patricians, vast fortunes being squandered in providing delicacies from all parts of the empire. The gormandizing instincts of these Roman epicures have their modern analogues in aristocratic circles in Europe and America. The luxurious catering establishments, the elaborate *menus* served at fashionable clubs, and the ostentatious expenditure of tens of thousands of dollars upon the dinners that grace various social functions, are facts so patent in metropolitan communities as to need no more than mention. Indeed, it may be laid down as a law that wherever great wealth and luxury exist side by side with inferior intelligence the first sign of decadence appears in the resurgence of the primitive instinct of sense-repletion, as illustrated in some form of gluttony.

Drunkeness is closely related to gluttony, and almost invariably accompanies it. This is as true historically as it is from the standpoint of current social customs. Both are the derivatives of a very primitive and voracious appetite. Wherever savages have been able to invent intoxicating drinks, they have used them to excess; and wherever they have secured the more intoxicating liquors of civilization, they have drunk themselves to extinction. The savage is the drunkard par excellence, and the appetite among civilized peoples that craves

[1] Oswald: *Dietetic Curiosities*. Popular Sci. Mo. Vol. XIV, p. 730.

intoxicants must be regarded as primarily a gross animal appetite, rendered persistent through an arrest of psychical development and given direction by the environments of civilization. This is not to deny that drunkenness is immediately induced by other causes, as in the case of mental affections, which antedate the drink habit. But the general character of the appetite for drink, combined with the physical and psychical attributes of those who become the typical drunkards of civilized communities, indicate a diathesis springing from the same tap root as gluttony. And even in the case of those who take to drink through antecedent disease, the question as to why their disease should take the form of drunkenness remains to be answered. We have got beyond the time when such a phenomenon can be explained as mere chance. And to say that, under such circumstances as those attending dipsomania, a man or woman takes to drink because of a craving for stimulants, explains nothing. It is certainly more rational to suppose that in drunkenness, as in most of the other vices that appear to come into prominence as concomitants of mental disease, we have to do with a law of evolution. Why not regard such vices as an expression of the fundamental diathesis of the individual, freed from the inhibitory restraints of higher levels of consciousness that are now in process of dissolution?

(d) While the causes that produce *unchastity* are complex, it is not improbable that here, too, we have to take into account arrest of psychical development. Organic life fundamentally unfolds itself in men as it does in animals. The sexual system is elaborated with the same care, and makes its demands in accordance with the same general laws in one case as in the other. It is only as intelligence and morality react upon the instincts which express an organic need, that men come to follow sexual laws at all different from those followed by animals. In other words, sex-differentiations in men are essentially psychical. Now, if for any reason psychical differentiation does not take place, and if, as is usually the case, organic sex-development proceeds, it necessarily results that a sexual animal is produced without the psychical concomitants of a sexual man. Upon such an hypothesis we would expect to find in civilized life every form of sexual manifestation, from the unrestrained appetite of animals and the scarcely less unrestrained lust of savages up to the subdued and thoroughly controlled sexuality of the highest types of men and women. And this is what we do find. In proportion to the level of psychical development attained by each individual is the primitive sex-diathesis subordinated. And in proportion as development has been interfered with does the primitive sex-diathesis assert itself. This does not imply that there is any less perfectly developed sexual

system or any less organic need in the highest creature than in the lowest one. It implies merely that sexuality in civilized communities is now conditioned by chaste personal conduct and by obedience to social customs and laws.

Of the arrests in sexual development among civilized people the one most suggestive of animal sexuality is masturbation. This is essentially a phenomenon of childhood and early adolescence, and is an expression of an awakening sex feeling unduly stimulated, perhaps, by environments, and seeking its gratification by any means whatsoever. The young of many animals show an altogether similar disposition. Young dogs, pigs, cattle and horses evince their first sex yearnings by sporting with one another, regardless of sex. Many of the males, at least, masturbate constantly. This phenomenon, as seen in children, is far more common than is generally acknowledged. The taboo that is placed upon such subjects by parents and educators has hitherto relegated them to the private speculations and discussions of children themselves and to the purveyors of quack literature. As a result there is probably no subject upon which there is greater ignorance. An illustration is found in the popular opinion that children will not acquire this habit except by example, and by the opinion prevalent among at least some medical men that the habit is usually the sign of disease. The obvious conclusion from such opinions would be that if a child is healthy and has no evil associates it will run no risk of self-pollution. Both of these opinions have truth in them, and the precautions they suggest are salutary. But it is certain that children may form such habits, exactly as the young dogs and pigs do, in trying to gratify instincts that are deeper than imitation or any conditions produced by disease.[1]

Cases of masturbation among boys and girls of 5, 6, 7 and 8 years are relatively common. To explain the beginnings of sex gratification in such young children upon the hypothesis of arrested development is of course impossible and unnecessary. They have not yet reached the age when we can speak of arrested sexual development at all. They are probably manifesting instincts, somewhat precociously, it may be, but nevertheless innocently, just as young animals manifest them. But, suppose that this naïve animal tendency persists into mature years, either through the ignorance of the child or its parents, or through an arrest of psychical development induced by the habit itself or by some other means, and we have just the condition met with in the perverse sexuality of thousands of adolescents, as well as in mature men and women. It is to such

[1] See report on masturbation among infants, by Dr. Townsend, in *Archives of Pediatrics*, Nov., 1896.

that the term "arrested development" may be legitimately applied.

Most reformatories, prisons, and insane asylums afford illustrations of this primitive animal sexuality, while society everywhere contains individuals who sustain normal relations to it, yet whose lives are dominated by a passion that daily jeopardizes their own well-being and often that of individuals about them. A few cases will suffice to illustrate: C., a man aged 36, born of well-to-do and healthy parents; a strong, active, but sexually precocious child; began to masturbate before he was 8 years old and continued the habit regularly until he was 17, when he learned its consequences and tried to stop it; tore himself away from his old associations, educated himself and became a successful teacher, meanwhile struggling against his appetite; made a silent but heroic fight for ten years; then gave up in despair, and is now half imbecile in character, alternating between moods of stupor and suicidal mania. S., aged 26 at the time of his death; born of well-to-do and respectable parents; learned to masturbate and to be incontinent with little girls while he was yet in graded schools; had precocious and strong sexual appetite, which within a few years completely mastered him; tried frequently to reform himself; gave himself a college and medical education, meanwhile adding associations with abandoned women to his solitary vice; located in a large city, and kept mistresses one after another; gave up the struggle with his sexual appetite at 26, and committed suicide. A., aged 29; born of wealthy and cultivated parents; had good educational and social advantages; was a strong, healthy boy, but became impure in the early teens and from that time on was more and more addicted to incontinence, both with girls and in solitary vice; began to frequent houses of prostitution at 22 and practiced frightful excesses; at 25 kept an extremely depraved mistress who acquired great influence over him and from whom he submitted to oral manipulation; spent all his income upon this mistress and forged checks for large sums of money with which to gratify her vanity; kept up such practices until he was brought to justice. G., aged 25 at the time of her death, became unchaste when 9 or 10 years old, and thereafter was more or less constantly lewd among her schoolmates; at 17 began to prostitute herself under cover of pretended visits to neighboring cities, and dressed flashily; at 22 married an indolent but fairly respectable man in her native town, and tried to restore herself to a social position, meanwhile, however, keeping up clandestine relations with different men; at 25, died from syphilis. M., a woman of 23, had the reputation of masturbating and teaching the habit to other girls at the age of 8 years; became notoriously

unchaste with boys at 12, and grew to be the terror of the neighborhood; bore an illegitimate child at 16, and thereafter alternated between a life of prostitution in the cities and indolent enjoyment of her income in the country home of her relatives.

With this class of sexual offenders belong many of the common prostitutes. From answers received from competent authorities in the various great metropolitan centers, Dr. Wood Hutchinson concludes that 5.6 per cent. of all the prostitutes are drawn into their course of life by sexual appetite alone, most of the others being the victims of vanity and idleness. This per cent. is small, but it indicates the presence in society of a class of women who depart radically from the civilized type. With this class also belong those youth and men, half imbecile in character, who hang about the parks and alleys of the cities, gratifying a prurient curiosity with little girls and sometimes insulting women with indecent remarks or with exposure of person.

Not so close to the animal type of sexuality, but rather illustrating the persistence of savage instincts, are the rapists. Among savage peoples, force is often employed in sexual union. Marriage by capture is common in some races, and in most races women cannot leave the neighborhood of their own huts without due precautions. Among some of the American Indians a woman found outside of the camp belongs to any man that can capture her. It is not strange, therefore, that the crime of rape should be so common among our negro and Indian populations. According to the United States census for 1890, there were confined in the various prisons 814 white rapists, 569 negro rapists, and 8 Indian rapists. Upon the basis of 1,000,000 inhabitants of each of these divisions of the population, the ratios are 14.2, 23.4, and 24.8, respectively. The total number of persons, including juvenile offenders, that were in prison for rape in 1890 was 1,408. Add to these 2,809 persons confined at the same time for incest, crimes against nature, fornication, etc., and we have a total of 4,217 persons in the United States that were guilty of grave sexual offenses. This is 4.3 per cent. of all the delinquents in confinement, and represents sixty-seven individuals to every million of the population. The fact that in a nation of 62,623,250 people 4,217 persons are in confinement for acts of savage and bestial sexuality that have been detected, proves the persistence of a very primitive sex diathesis in the midst of civilization.

(e) In *assault* upon the person there is involved a purpose to injure or kill a fellow-creature. This may proceed from the instinct of self-defense or from malevolent passions excited by

other causes. In any case, however, the man who lays violent hands upon another man aims, unconsciously or consciously, at the destruction of life. Such an act reveals the animal and sub-human instincts that were once economical, but are now self-destructive as well as anti-social. "Whoso sheddeth man's blood, by man shall his blood be shed," expresses the law that has governed society's treatment of the assaulter from the time when the family avenged the injury or death of a member to the present, when the power of avenging rests with the State. So long and so carefully has society guarded the life of its members that the elimination of the instinct to kill has perhaps proceeded farther than that of any other instinct. Even children respect life, normally, and except in their tendencies to be cruel in teasing or domineering over playmates, there is nothing to indicate a passion strong enough to seek gratification in murder. Yet individuals exist in every community that are probably capable of shooting, stabbing or poisoning a fellow-being. In most cases this disposition comes to light only when rage, hate, or revenge dominate the mind, and, under such circumstances, the question may well be raised whether most persons do not glimpse the possibility of murder. In some cases, however, the disposition to kill is but little, if at all, concealed, and manifests itself in every degree of insanity, from fighting with fists and clubs to deliberate destruction of life.

The willingness to kill a man or to commit any assault upon him that involves the possibility of his death, is a disposition so alien to the altruistic spirit of civilization that it can be explained only on the hypothesis of an imperfectly developed human being. From some cause the psychical qualities of the animal or sub-human ancestors have persisted just as they have persisted in the idiot. This is illustrated in such well-known cases as Jesse Pomeroy and the murderer Holmes, where the most inhuman crimes were committed merely incidentally to the pursuit of the ends of self-realization. It is just as in the case of the tiger that drags to the earth an antelope, gorges itself upon its flesh, and then passes on indifferently to its lair; or in the case of the savage that shoots another savage through the heart, possesses himself of his hunting equipments, and proceeds in further quest of game or plunder. It is illustrated in the case of such burglars as Kelly, who went into a bank with a bag to carry away the booty, and with a slung-shot and razor to kill any one who might get in his way. When the aged cashier made the resistance that was expected, Kelly merely did what he was prepared to do, felled him to the floor with the slung-shot and then cut his throat. It is illustrated in such criminals from passion as Madame DuTilly, who threw vitriol in the face of a rival; of Madame Darn, who stabbed her

husband to escape his brutality; and of Marie Barberi, who killed her lover because he had seduced her and then treated her with scorn. Such and similar cases swell the total of homicides to relatively vast proportions in the most highly civilized countries. According to the official census for 1890 there were confined in the prisons of the United States 7,351 persons convicted of homicide, or 89 to every 1,000,000 of the population. The ratio of the different elements of the population guilty of this kind of crime are quite as significant as in the case of rape, affording an incidental support to the hypothesis advanced in this study. Thus, the ratio per million of white persons was 77.2; of negroes, 112.8; of Chinese, 230.9; and of Indians, 285.7.

§ 5. Hypertrophy and Disease Due to Arrest.

The persistence of regressive structures and qualities is sometimes accompanied by hypertrophy and disease. The *vermiform appendix*, which is usually about 8½ cms. in length may grow to a length of 20 to 23 cms. It is subject to pathological changes and is the seat of the fatal disease known as "appendicitis." The *thyroid gland* is normally a regressive organ. In the new-born infant its proportion to the weight of the body is as 1 : 240 or 400; at the end of the first three weeks, it is as 1 : 1160; and in the adult, it becomes as 1 : 1800. It is sometimes much enlarged, this tendency appearing to increase under certain pathological conditions. Thus, in monstrosities, it is frequently found to be enlarged, according to the descriptions given by Otto.[1] It is also associated with cretinism. In advanced life it is liable to become indurated, and frequently contains earthy deposits. Its vesicles also attain a very large size. Its most characteristic disease, however, is goitre, when the neck may not only become greatly deformed, but when also the goitrous growth may become so great as to hang down half the length of the body. The persistence of the *cervical ribs* is frequently accompanied by aneurism of the subclavian, and the obliteration of the arteries supplying the upper limbs. In some cases there are neuralgic pains in the forearms and fingers and other troublesome symptoms, necessitating the removal of the abnormal ribs. The persistence of the didelphous form of the uterus is sometimes of such an exaggerated type that there are two distinct organs, and the woman becomes not only subject to such disorders as may arise from a condition so anomalous, but also unfitted for her functions as a woman. A case is described by Ameiss[2] in which a complete septum half a centimeter in thickness extended throughout the vagina;

[1] *Monstrorum Sexcentorum Descriptio Anatomica.*
[2] *American Journal of Obstetrics*, Vol. III (1896).

while the uteri were entirely separated, the left one being 5 cms. deep and retroverting towards the left, and the right one being 4 cms. deep and retroverting towards the right.

These exaggerated types of rudimentary structures shade off into the anomalous organisms called "monsters." Probably most of the latter illustrate in some detail the persistence of conditions peculiar to lower developmental stages. Monsters are now considered to be due to arrested development, so that their connection with rudimentary organs and the general law of regression becomes evident. Thus Fisher[1] says: "It has been observed by eminent embryologists that the transient forms of the human embryo, in its several stages of evolution, bear a striking resemblance to the persistent types of the lower orders of animals; hence, the human malformations which result from arrested development often acquire the appearance of brutes, while those occurring in animals, for the most part, have the forms of beings still lower in the scale." The general resemblance of human monsters to lower animals was observed long before science came into existence, and all kinds of superstitious beliefs were entertained concerning it. Thus, it was thought that such monsters were the products of unions between women and brutes or between women and devils. The belief still exists that they are the result of "impressions" received by the mother during pregnancy. Such resemblances are certainly met with, as any one must own who has examined the specimens in a well-equipped museum of pathological anatomy. Medical literature records occasional instances in which these resemblances occur. Thus, Lambeth, in the *Weekly Medical Review*, of St. Louis, describes the case of a male child "whose every feature resembled that of a much excited but harmless cow." Hord, in the *Chicago Medical Journal and Examiner*,[2] describes a case of monstrosity in the form of "a child with a dog's head." Hamilton, in the *Northwest Medical and Surgical Journal*,[3] gives an account of a "monster with a head resembling a dog's." Gregory, in the *Philosophical Transactions* (London),[4] tells of a monstrous human fœtus "resembling a hooded monkey."

While fancy has played its part in the detection of brute-resemblances, there is no doubt a residuum of truth in the belief that these resemblances are real. If every human embryo does indeed recapitulate the stages of phylogenetic development, and if monsters are due to an arrest in embryonic

[1] *Reference Handbook of the Medical Sciences*, Vol. VII, pp. 1–28.
[2] Vol. XLVIII, p. 246.
[3] Vol. V, p. 455.
[4] Vol. VIII, p. 314 and Vol. IX, p. 316.

development, it is entirely reasonable that certain brute resemblances should now and then come to light so as to attract even general notice. When the anatomy of such monsters is examined more in detail, it is found that the superficial resemblance is but an expression of structural conditions actually present. About the beginning of the second month of fœtal life, four papillary prominences or embryonic buds appear. These are the beginnings of the arms and legs. Now if the development of the limbs is arrested at this time, various forms of *Amelia* occur that recall lower stages of development. The arms and legs may be short and set at such an angle as to resemble closely the flippers of a seal. The toes and fingers may be webbed like those of various animals. The limbs may appear to develop after the Simian type, the arms being relatively longer and the legs and feet showing an exaggeration of the usual structural resemblances to those of apes. Previous to the end of the third week the head of the embryo is not discernible, being undifferentiated from the body. After this period, during the fourth week, it develops so rapidly as to be equal in bulk to the trunk. *Acephaly* would therefore occur if an arrest of development took place during this period; while every gradation of incomplete cephalic development may result from subsequent arrests. Here is suggested the rationale of all those brainless and half-brainless monsters, from the acephalous type, that is not viable, to the microcephalic idiot that lives and becomes a burden upon society. It is not unreasonable to suppose that all of them represent brute stages of development, and that their strange resemblances to animals is not accidental but inevitable, as an expression of law. The human face, like the head, passes through a series of developmental stages, arrest at any one of which may perpetuate brute elements of physiognomy. During the sixth week, the anterior portion of the pharynx presents a large opening bounded by the facial arches. This opening is afterwards partially closed as the different parts of the face are formed. Arrest of development produces the facial fissures, such as single and double hare-lip, cleft palate, etc. The jaws, mouth, and especially the nose in monsters frequently perpetuate the animal types. All of the structures of the reproductive system in monsters may take on forms suggestive of those found in animals as permanent organs. Thus double uterus and vagina, hermaphroditism, hypertrophied external genitals, and other anomalies are frequently met with.

Whatever one may think of these monstrous organisms that appear here and there in human life, he is bound to suppose that they are produced in accordance with creative law. Goethe has said that it is in her monstrosities that Nature reveals her

laws. We must regard them as illustrations of the extreme types of organic retrogression. The forces of life are so far spent that elaboration cannot longer proceed normally, and all the heritage of organic debris becomes persistent and diseased through the failure of creative energy to eliminate it. In other words, the hypothetical condition described by Weissmann[1] in his statement of the rationale of rudimentary organs has been realized: "If Nature were not able to effect the disappearance of superfluous organs the transformation of species would have been well-nigh impossible, for the existing parts which had become superfluous would have been in the way of other active parts, and would have hindered their development. Indeed, had all parts which the ancestors possessed been necessarily retained, an abnormal animal would at last have been produced—a monster no longer capable of living."

The law that thus reveals itself in pathological anatomy has its application also in the field of morbid psychology. The animal and sub-human qualities of the human soul that we have found to be persistent under conditions of arrested development, are liable to perversions of every kind. There are exaggerated or diseased appetites and passions that produce monsters of gluttony, lust, cruelty, hatred, and egoism in general. Such are best illustrated in insanity. The belief in a type of insanity that is related essentially to the moral nature has been very generally held. Pritchard, Georget, Pinel, and Esquirol believed that there is a moral derangement without appreciable intellectual error or delusion. Esquirol says; "There are madmen in whom it is difficult to discover a trace of hallucination, but there are *none* in whom the passions and moral affections are not disordered, perverted, or destroyed." In forty years' experience in the Salpêtrière and Charenton, and in his private practice, Esquirol states that he met no exception to this rule. Pritchard defined "moral insanity" as "a madness consisting in a morbid perversion of the natural feelings, affections, inclinations, temper, habits, moral dispositions and natural impulses, without any remarkable disorder or defect of the intellect, or knowing and reasoning faculties, and particularly without any insane delusions or hallucinations." Carpenter says: "Moral insanity may, and frequently does, exist without any disorder of the intellectual powers, or any delusion whatever." Clouston says:[2] "There are many cases where the moral defects are the disease, the intellectual defects, if present, being so slight that they would not

[1] Quoted by Wiedersheim: *Structure of Man*, p. 212.
[2] Mental Diseases, p. 350.

have constituted insanity or have interfered with the patient's work or position in the world."

How, then, may moral insanity be explained? If it occurs in those individuals who have shown a progressive evolution of immorality, it cannot but indicate the persistence of rudimentary qualities exaggerated into criminal and then into insane proportions by arrest of development and by the pathological conditions such an arrest of development might induce. The following case cited by Clouston will illustrate:—A boy, F. I. "No one who knew him ever believed a word he said. He stole, he had small affective power, and he never seemed to see why anybody should be offended at acts of immorality or dishonor, though carefully and religiously brought up. In after life, he turned out a selfish and negatively immoral man. He never paid any debt that he could help, and he borrowed from every one he could. He treated his relations badly. He on several occasions did public acts that might have brought him under the cognizance of the criminal law." Clouston further says: "Such cases are the bane and disgrace of their relations. Nothing can be made of most of them morally, any more than a genetous idiot can be converted into an active minded man. Wrong is right to them; they prefer lies to truth, immorality to morality." On the other hand, when moral insanity has not been preceded by immorality, so far as is known, but rather seems to have induced the latter, the explanation may be difficult. Doubtless, some such cases are the results of morbid processes quite remote from the vices and crimes they occasion. Yet, even here, why do these vices and crimes come to the front? Why should not an insane person become transformed into a pure and exalted type of manhood and womanhood, rather than into a filthy, licentious or murderous type, as is so often the case? Why have such creatures won, and doubtless deserved the reputaion of being *madmen?* It must surely be that the worst elements of human nature are always ready to assert themselves the moment reason is dethroned, or else a man's becoming insane might once in a while improve his character. Must not the vices and crimes of the insane mind spring from the same instincts as do vices and crimes generally? Must we not suppose that in such cases the fundamental qualities of the animal psyche come to the fore because they are the oldest and are mediated by lower levels of consciousness? If insanity is to be regarded as psychical retrogression, should we not expect that the more radical the process of disintegration in consciousness, the more active would be those elements of mind that minister to organic needs? Hence, the instincts that have to do with food, sex, and

self-preservation generally, would become dominant, and man, with his reason destroyed, would become literally a brute.

1. *Dipsomania* illustrates the diseased form of the drink appetite. Clouston defines it as "a morbid, uncontrollable craving for alcohol and other stimulants." "The morbid craving for alcohol is common, and so intense that men who labor under it will gratify it without regard to their health, their wealth, their honor, their wives, their children, or their soul's salvation." Such cases are common in every civilized community. Sometimes they are confined in asylums; but often they are members of society, propagating offspring, assisting in the government of towns, cities and nations, and not infrequently holding offices of responsibility. F., a man fifty years old, began drinking in his youth, but not to excess; was well connected, talented, and secured an excellent education; was admitted to the bar and practiced law for a number of years with great success; meanwhile, he drank harder and harder, and finally began to be irregular in his work and unreliable in his dealings; at last lost his practice, became a burden upon his family, and was sent to a "gold-cure" establishment; returned home "cured" and renewed his practice of law with prospects of success; took to drinking again, however, sank lower and lower, and is at present in an inebriate asylum. S., a laboring man, was at one time a skilled and reliable workman; took to drink, became irregular in his habits, and lost his position; went to still greater excesses, had delirium tremens, lay in drunken stupors for hours and was finally sent to an asylum; was released after a time as sufficiently reformed, but soon began drinking to excess, and ended his life by consuming a large amount of raw alcohol. Such cases could be multiplied indefinitely. Most of them are the same story of moderate drinking, excessive drinking, attempts at reform, relapses, greater excesses, delirium tremens, a prolonged debauch, death.

2. *Kleptomania* illustrates the diseased form of theft. It is an uncontrollable impulse to take whatever strikes the fancy, and is met with among imbeciles, general paralytics, and other classes of the insane. Frequently, however, it is found among people outside of the asylums, women, and especially women of the upper classes, being subject to impulses of this kind. It is the opinion of criminologists that the sense of property in all women is weak, which fact may account for the greater prevalence of kleptomania among them than among men. Their love of dress, and the temptation thrown in their way in the stores and shops to pick up little articles of finery, may also have its influence. An inspector of the Bon Marché, in Paris, is of the opinion that twenty-five per cent. of the shoplifters are habitual offenders who rob whenever they can,

twenty-five per cent. are impelled to the act by want, and fifty per cent. are kleptomaniacs of good social standing and wealth, who simply appropriate pretty things from the counters because they can't resist the temptation to do so.[1] Almost every community has its kleptomaniac among the wealthier class, enjoying immunity from prosecution because of the prominence of the family, or the respect and pity felt for her husband. Mrs. F. was well known throughout a town of 10,000 inhabitants as a shop-lifter and pilferer from every house she entered. Her husband had an understanding with the proprietors of stores that they present bills to him for any articles they knew his wife to take. Similar arrangements existed by which neighbors and others could recover their missing valuables by going to the house. In a city of 100,000 inhabitants, the chief of police was at one time informed that flowers were being systematically stolen from the graves in the principal cemetery. He set officers to work at the case, and discovered that the offender was a prominent woman of the city, who was an all-round shop-lifter and under constant surveillance. She had never been prosecuted, for reasons similar to those given in the case of Mrs. F. The recent case of Mrs. C., who was apprehended in London when she and her husband were just on the point of sailing for their home in the United States, excited international interest. This woman was wealthy and extremely well connected. Yet she had stolen thousands of dollars' worth of tid-bits of every kind as she travelled about from place to place. Even the silver and table linen of hotels had not escaped her desires. She was prosecuted and convicted, but was afterward pronounced irresponsible by high medical authorities and was released from custody to return home.

3. Hypertrophy of the sexual instinct manifests itself in a variety of ways. Thus, in *satyriasis* and *nymphomania*, there is an uncontrollable impulse to satisfy the sexual appetite without regard to circumstances. The desire may be so intense as to lead to murder if opposition is offered to the person. Doubtless many of the rapes, accompanied with the killing of the victims, that occasionally occur in every large community, are committed by this class of individuals In *Sadism* there is a morbid inclination towards the opposite sex, accompanied with a desire to inflict pain and injury. This is probably but an exaggeration of the rudimentary animal or savage impulse to conquer the woman in connection with sexual union. Thus lust comes to be associated with the most brutal acts, such as beating, cutting, and mutilation. Such crimes as those of "Jack the Ripper," where the murdered women were always mutilated in a

[1] Lombroso: *The Female Offender* (Morrison's Translation), p. 207.

particular fashion, are probably the work of men thus sexually diseased. In *sexual fetichism*, some part of the female body, as the neck, hand or ankle, or some article of dress, or even the natural odor of the body of the female or the perfume she uses, is sufficient to excite voluptuous sensations and produce involuntary pollutions. In *masochism, pederasty, sodomy*, "*Lesbian love*," etc., there are various gross inversions of the sexual instinct, leading to vices that are unspeakably loathsome. Most of these sexual aberrations are reducible to a primarily strong sexual appetite, rendered more intense by gratification or disease, and given its particular direction by the circumstances surrounding the individual. That they are far from rare in the most highly civilized countries past and current history conclusively proves. Indeed, it is in man's sexual nature that the grossest perversions of character are wrought. The history of moral pathology in the individual and in society would be largely the history of abnormal sex-relations.

4. *Homicidal mania* illustrates the pathological form of all those fundamental egoistic instincts that center in love of power over others,—hatred, revenge, envy, jealousy, etc. There is present an uncontrollable impulse to lay violent hands upon or kill persons indiscriminately, and this impulse is a common symptom in some forms of mental disease. Thus, frequently in epilepsy the patient believes himself to be injured or persecuted by others, and obeys the natural animal impulse to rid himself of his supposed enemies. The murderous impulse manifests itself in the insane forms of *jealousy*, especially in women. An English woman believed that a certain doctor would marry her if his wife were out of the way. She therefore became madly jealous of her rival, and succeeded in putting poison into some cream chocolates that she knew the latter would eat. In melancholia the patient sometimes harbors suspicions and broods over supposed wrongs until he becomes possessed of an impulse to kill those about him. Children occasionally show homicidal tendencies, either as a result of antecedent brain disease, or from a morbidly imitative disposition that takes its cue from accounts of murders, sensational stories, etc. Delirium tremens, also, sometimes takes the form of an impulse to kill. In short, any of the malevolent passions which incline a person to do his enemy injury, but which in rational minds are usually controlled, may assert themselves in an effort to injure or kill when the mind is deranged.

5. Besides these more typical exaggerations of instinctive tendencies found in mental disease there are numerous others illustrating the same law of regression. Sometimes there are perverted food-appetites that find gratification in eccentric and even monstrous methods. We know from the Hebrew Scriptures

how the mad Nebuchadnezzar "did eat grass as oxen, and his body was wet with the dews of heaven, till his hair was grown like eagles' feathers and his nails like birds' claws." Filth of all kinds may be eaten in certain forms of insanity, while cases have been known in which cannibalism occurred. Probably it would be scientific, as well as charitable, to suppose that the starving men who have been known to eat their comrades were, at least, temporarily deranged. Destructive tendencies frequently appear, *pyromania*, excessive vanity, as in *delusions of grandeur;* morbid suspicions, as in the *mania of persecution;* and, in fact, innumerable exaggerations of traits that lurk in every man's and woman's character, but which are ordinarily repressed and concealed by the higher intellectual and emotional attributes. In all such cases we must suppose that one of two general forces is at work; either the weakened condition of the mind has become the occasion for the outbreak of otherwise unsuspected appetites and passions, or the appetites and passions have gradually asserted a complete dominion over the powers of the mind that usually inhibit and repress them. In the language of Clouston, "The driver may be so weak that he cannot control well-broken horses, or the horses may be so hard-mouthed that no driver can pull them up."

The following explanation given by Clouston of what he calls *Animal and Organic Impulse* is confirmatory of the point of view taken in this section: "Under this term I include all the uncontrollable impulses towards sexual intercourse, masturbation, sodomy, rape on children, bestiality, etc. The perverted instincts, appetites and feelings shown in urine drinking, eating stones, rags, clay, nails, etc., come under this heading, too. *There are few cases of mental disease where some appetite or instinct is not in some degree perverted or paralyzed. But there are cases where such things are so prominent as to constitute disease.*[1] I have a patient who assures me that his desire to masturbate is an irresistible craving which he has no power to control. Here is a girl who rubs her thighs together to produce sexual excitement the moment she sees a man. Here is a case of nymphomania, who rushes towards any man she sees, and can scarcely be held by two attendants. I believe there are cases where there is an irresistible impulse towards sodomy and incest. Many of the men who commit rape on children are insane. I lately had to give evidence at the Carlisle Assizes about the insanity of a medical man who had tried to commit rape on three children under age in succession. No doubt he had the delusion that God had in some occult way revealed to him that he should beget a male child, and had sent the little girls to

[1] Italics mine.

him for this purpose; but he was practicing his profession up to the commission of the act. I have referred to the case of the young woman who had an impulse to eat clay and dirt every time she menstruated. She could not help it, and had no such tendency between. A shoemaker patient in the Prestwich asylum swallowed a few shoe nails every day, and, which was strange, was none the worse. There is an infinite variety of such impulses."[1]

§ 6. Prepotent Retrogression.

The different organic and psychical elements retrograde concomitantly, and the extent of the retrogression is determined by the grade or level of the principal element involved. An illustration drawn from the nervous system will, perhaps, serve to make this part of the discussion clearer. According to the segmental view of the spinal axis we may regard it as made up of three grades of meristic levels. First, there is a series of levels below the medulla, in which the organs represented by each segment have a certain independence, so far as nervous function is concerned. These sub-medullary levels are concerned only with the lower portions of the body. Next, there is the series of levels constituting the medulla, which, by the intermediation of centripetal fibres are brought into relation with the lower part of the body and its limbs, with the upper part of the body and its limbs, with many of the visceral structures, and with the organs of special sense. Finally, there is the series of levels constituting the cerebellum and cerebrum. These contain such a vast number of highly differentiated structures that they are not only brought into relation with every part of the nervous system, but also of themselves constitute that infinitely complex mechanism that has for its peculiar office the mediation of psychical activity. Now, if a variation should occur in one of the sub-medullary levels it would affect only those organs dependent upon that particular segment. If the variation should occur in the medullary levels, however, it might affect organs in the lower part of the body, in the upper part of the body, in the viscera, or in the structures concerned with special sensation. Finally, if the variation should occur in the brain levels themselves it might involve organs of any part of the body or brain.

Teratology is also suggestive in this connection. In human "monsters" there seems to be some relation between the number of anomalies and the gravity of the primary defect. The illustrations in teratological works such as St. Hilaire's, Forster's and Otto's, as well as the specimens in pathological

[1] *Mental Diseases*, p. 331.

museums, impress one with the large number of anomalies that appear in the worst types of monstrosity, such as acephaly, hemicephaly, etc. The detailed descriptions given by Otto[1] of two hundred human "monsters" have been examined with a view of determining whether such a general impression is correct. The cases examined fall into three groups: 1—those in which the primary affection was cephalic; 2—those in which the primary affection was visceral; and 3—those in which the primary affection was mainly in the limbs. The number of anomalies in each case was counted, omitting the primary affection. The following is the number of cases falling in each group, together with the average number of anomalies: 1—Brain, 70 cases, with an average of 7.3 anomalies; 2—Viscera, 56 cases, with an average of 4 anomalies; and 3—Limbs, 76 cases, with an average of 3.8 anomalies. Some additional weight is lent to these facts by the conclusions of criminal anthropologists and alienists as to the relation between psychical anomalies and the extent of the degenerative process in idiots, lunatics, and other defectives.

On the neurological side, the Hughlings-Jackson[2] theory of brain levels supports the law here referred to. This theory grew out of an attempt to explain the mental phenomena of epilepsy, insanity, etc. It supposes three levels of brain development, which mediate respectively three general classes of psychical phenomena. The *lowest level*, which includes the gray matter of the spinal cord and its extension into the brain proper as far as the oculo-motor nucleus, mediates actions of an organized or habitual character, such as certain movements of the limbs, the reflex visceral activities, swallowing, respiration, peristalsis of the intestines, vaso-motor and cardiac action, and the reflex movements of the pupils. This level of mind, therefore, has to do with the vegetative functions of the human organism. It belongs to the great sphere of the sub-conscious mind. The *middle level*, which includes the motor areas of the brain found in the two central convolutions bounding the fissure of Rolando and in other contiguous portions more or less indefinitely determined, mediate the various voluntary movements, such as those of the tongue, lips, arms, legs, and trunk. The *highest level* embraces the præcentral and occipital regions of the brain and is pre-eminently the organ of the self-conscious mind. None of these levels is altogether independent of the others. The nervous centers of the lowest level represent impressions and movements of all parts of the body most nearly directly, and are first in order of development from an evolu-

[1] *Monstrorum Sexcentorum Descriptio Anatomica.*
[2] *Journal of Medical Science*, Vol. XXXIV, p. 359.

tionary standpoint. The centers of the middle level re-represent what has been received from the lowest level, and are, in a sense, the outgrowth of the latter, while the centers of the highest level re-re-represent the impressions received by all the lower centers and work them up into self-conscious mind. That is to say, there is a kind of psychical hierarchy, the lowest centers controlling the vegetative life; the middle centers controlling the motor life, while at the same time being inter-related with the vegetative life; and the highest centers mediating the intellectual and moral life proper, while at the same time being inter-related with all that is below them.

The importance of this view of psychical phenomena lies in the fact that it recognizes substantially the laws that we have just been discussing as operative also on the mental side. That is to say, in mental diseases the higher the level affected, the more diffuse and radical will be the psychical disequilibration produced. In general, this is confirmed in the well known distinctions between the peripheral and central lesions in brain disease. For example, locomotor ataxy produced by syphilitic infection may at first be due to the degeneration of a special region of the spinal cord. At this stage, there is a simple inability to co-ordinate the movements of the lower limbs, and the mind proper is not impaired. But as the degeneration advances upward to the higher levels the symptoms become more and more grave, until at last, when the centers that mediate the larger apperception groups become affected, profound mental and moral disturbances occur. Another important implication in Hughlings-Jackson's view is that of the greater instability of brain centers, and the concomitant psychical phenomena of the highest and most recently organized levels. According to this view, those centers which have been the last to develop and which are therefore the highest will be the first to yield to degenerative influences, since they are the most unstable.

Now, the moral sense, as we find it in civilized man, marks the culmination of the evolutionary process. Morality, in the race as in the individual, implies a high degree of complexity in the psychical organization. To be absolutely moral would necessitate apperceptions of the infinite; to be relatively so necessitates the apperception of very intricate personal and social relations. Representing the highest level of psychical organization, the moral sense is immanent throughout the entire complex of ideas and emotions. Just as the highest centers of the brain discharge their energy along every nerve-fibre and into every cell, so do the centers of moral consciousness discharge their energy along every channel of feeling. And just as the degeneration of the highest brain-centers throws out of equilibrium the entire psychical mechanism, so does the degeneration of the

moral consciousness destroy the soul. This is not a mere speculation. To say nothing of the testimony of religious teaching everywhere, or of that supplied in the history of decadent civilizations, there are all about us examples of moral degeneration which are accompanied by mental and physical degeneration. The immorality of the drunkard destroys his mind and his body by inducing morbid processes in the nervous and other tissues, by causing defective inhibition of other appetites, and by destroying gradually all that power of harmonious adjustment to environment which the race has built up. The drunkard is usually licentious and gluttonous, he is improvident, and he is generally deficient in his moral and intellectual perceptions. The same is true of opium eaters and all other victims of stimulants and narcotics. The immorality of the thief or of the dishonest business man affects the entire character. The sense of personal honor is one of the highest attainments in evolution. Destroy this sense, and almost everything else comes easy. Theft or dishonesty of any kind is always attended with falsehood and deception, and is often attended with such a loss of self-respect that vice of every description is recklessly indulged in. The immorality of unchaste men and women also affects the entire character. Sexual offenders of both sexes are notoriously untruthful, often dishonest, and sometimes cruel and depraved in every way. It is not entirely due to social ostracism that a woman who loses her virtue usually goes rapidly to the extremes of degradation, or that a business man who loses his sense of honor often takes to gambling, drinking, etc. In all such cases, the very highest apperceptions of consciousness are disturbed, and it is no wonder that a general moral obliquity results.

Again, and finally, just as the highest brain centers are the most unstable and the first to feel the effects of degenerative influences, so is the moral consciousness the most unstable and the most sensitive to stimuli of a harmful character. Illustrations of this principle are numerous. The moral natures of men everywhere show the effects of such an instability. The sudden break-downs of character frequently astonish and dismay society. A man fifty years old, who has been a good husband and father and an upright business man, decamps to some foreign country, and his relatives and friends are compelled to face the fact that he has defaulted for $250,000. A little later, and humiliation is increased a thousand-fold by the discovery that he has spent a large part of the money upon an adulteress and that he has now left home and family in the company of this woman. A young man who has been the trusted messenger of a metropolitan bank, and who has enjoyed the confidence and even the personal affection of his employ-

ers and associates, suddenly disappears with $30,000 of the bank's money. A minister who has an extensive reputation as a scholar, college president, and active citizen, and who is the husband and father in a cultivated household, puts all these things out of his life forever by eloping with a young woman who has been employed in his office. Such cases might be indefinitely multiplied. Now there is a disposition among some criminologists to explain these sudden lapses in moral conduct as symptoms of mental disease; and there is doubtless considerable truth in such an explanation in certain cases. But from the standpoint of moral evolution, which regards the sense of property, conjugal fidelity, and other elements of character peculiar to civilized communities as recent and unstable acquisitions, a different explanation is possible. From such a standpoint, it is reasonable to suppose that the susceptibility to temptations among men and women is a symptom not of mental disease but of a moral diathesis not yet fully established, and therefore unstable.

§ 7. Conclusions.

The proximate causes of that wide class of retrogressive phenomena variously classified as immorality, vice, crime and sin, may be summarized as follows:

1. *The temporarily incomplete elimination of qualities belonging to lower stages of development.* This type of immorality is illustrated in children whose moral nature has not yet adjusted itself to the standards of adult life; and in those adults whose development has been delayed, though not stopped, by unfavorable surroundings. Such immorality is transitional and temporary. It is analogous to the keel-shaped thorax and triradiate pelvis of childhood, and, like the latter, will be transformed at the proper time if the surrounding conditions be healthful.

2. *The total arrest of the eliminative process, leading to the persistence of qualities that should normally disappear.* This type of immorality is due to the fact that development has been arrested at some point in embryonic or post-natal life, thus perpetuating the psychical disposition of a normally transitional period. This marks the first stage of moral retrogression, and is illustrated in the delinquent classes generally, such as vagrants, thieves, sexual offenders, assaulters, etc. It is analogous to the numerous types of organic arrest. Thus the keel-shaped thorax referred to above may persist in what is called the pigeon-breast; the triradiate pelvis may persist in the rickety pelvis that, in woman, unfits for the reproduction functions; the fœtal lanugo may persist in the hairy covering that occasionally appears in men and women, etc.

3. *The hypertrophy or disease of abnormally persistent quali-*

ties, leading to a pathological condition of the moral nature. This type of immorality is due to very complex and obscure causes, but undoubtedly the simple persistence of animal and sub-human traits amidst an environment to which they are altogether alien is a prominent one. Just as the physical organism is apt to become diseased in surroundings to which it cannot adapt itself, so is the moral nature apt to become diseased in environments to which it cannot adapt itself. It is for this reason that an immoral character becomes self-destructive. Its existence depends upon harmonious adaptation to surroundings, which, in civilized communities, are essentially moral; and when this adaptation is impossible disease and death inevitably result. Moreover, it is undoubtedly true, as many authorities have asserted, from Morel down, that immorality accumulates through heredity. Families and communities degenerate from such vices as drunkenness, licentiousness, and the use of narcotics. It is not surprising, therefore, that the children of such families and communities should sometimes become morally insane. The higher and more unstable elements of the psyche are destroyed, the process of psychical elimination is stopped, and all the animal and savage traits of character assert themselves and dominate the individual. Here retrogression is far advanced, as is illustrated in such monstrosities of character as dipsomania, kleptomania, sexual perversion, and all those neurotic and unstable types of mind that constitute the decadent elements of society. This type of immorality has its analogues in the physical monstrosities that either make life abortive, or disfigure it with such blemishes as webbed hands and feet, cervical and facial fissures, hermaphroditism, etc.

No claim is here made to an original view of the nature of immorality. The idea that men's nature bears the traces of ancestral conduct that must somehow be eliminated is as old as the doctrine of "original sin." While the idea that immorality tends to become persistent and, finally, self-annihilating, is but a re-reading of the sentence "The wages of sin is death." Nor is it claimed that such a view explains the ultimate causes of immorality. What is back of all these phenomena of progress and retrogression is a matter of faith and not of knowledge. As in any other question to which the theory of evolution may be applied, it is the interpretation of facts that is changed, and not the facts themselves. The eternal truth that there is something in the universe that makes for righteousness, and something in the universe that makes for sin, will remain after science has said its last words. The most obvious implication of such a view of immorality is the unity and immutability of law. To say that the vices and crimes of men may be explained by nat-

ural methods is not to ignore supernatural methods. It is merely to assert the truth, which men have been too slow to learn, that *natural* laws are also *supernatural* laws. Both materialistic science and dogmatic religion are atheistic when it comes to an interpretation of nature, for neither believes that God has anything to do with it. How else could such antinomies as "natural law" and "spiritual law," "natural man" and "spiritual man" have been invented? To place the subject of immorality upon a basis at once natural and supernatural is the first desideratum in moral culture. When this has been accomplished men will be willing to learn Nature's methods of dealing with their vices and crimes, and they will at the same time perceive that these methods are too intelligent and beneficent to be explained on mechanical or chemical principles.

Considering the subject of immorality from such a point of view, what would moral pedagogy adopt as its guiding principles?

1. It would recognize that a large proportion of immoral tendencies are due to the incomplete elimination of animal and sub-human traits. These, however, are in process of elimination, and, under normal conditions, may be expected to recapitulate the phylogenetic process until the individual realizes the type of his race and civilization. That is to say, the process will be analogous to what takes place in the organism where such vestiges of an animal ancestry as the sublingua, palatal ridges, thyroid gland, etc., become more and more reduced as the child grows into the physical type of his race. Such a recognition would make moral education at once rational and optimistic. The task would be a hopeful one, because Nature would be on the side of the parent or educator; and it would also be a definite one, because both the conditions to be met and the means of meeting them would be better understood.

2. It would recognize that education as a moral agency must be chiefly serviceable during the periods of life that recapitulate the great groups of genetic instincts and habits. For it is then that the transforming influences of civilization must especially cope with hereditary tendencies, and it is then that the latter will be eliminated, if at all. Such are the periods of childhood and adolescence. The first of these is rife with food appetites, explosive emotions, and excessive egoism generally. It is here that gluttony, theft, deception, anger, stubbornness, destructiveness, filthiness, cruelty, and vagrancy are apt to reveal themselves. The dangers of the second period center in the awakening sex-consciousness. Here appear tendencies to sexual impurity, display and extravagance in dress, vanity, jealousy, and envy. The stress of moral education should therefore be placed upon these crises of development.

3. It would choose its methods of moral training in conformity with the suggestions of Nature, whose pedagogics are being reinterpreted by modern science, and especially by genetic psychology. It is believed that some of these methods have been emphasized in this study. First is that of conservatism. We have found that Nature works slowly and patiently. She has never extirpated a single organic structure or psychical quality outright, but has reduced them gradually. She has been satisfied to spend thousands of years in eliminating the animal and savage instincts of mankind, and even at this late day allows the children of civilization to pass through a savage or half-savage state, preliminary to the refinements of civilization. This means something to the parents and educators who will think about it. There is certainly prevalent a tendency to force moral and religious training upon children. The "thou shalt not" of moral discipline is too often concerned with the repression of healthy instincts. Children are forbidden to range the fields, climb trees, paddle in the water, and begrime themselves with dirt; they are cooped up in the prim little kindergartens, watched over by nurse girls, or led around in curls and smug costumes by dainty mothers. Truancy from school is made an offense punishable by confinement in truant schools; and boys whose instincts are often healthier than those of the officials who try to control them are made to believe that it is a crime to love the woods and watercourses better than the tedium of a school-room. It would be difficult to devise a surer way of emasculating childhood and of producing a precocious and morbid manhood and womanhood. Again, Nature eliminates by causing the organ to cease functioning and then allowing it to atrophy by withdrawing its nourishment. Here is suggested the rational process of moral training during the first period of development. It is not didactic moral or religious instruction that is needed in childhood so much as it is the prevention of injurious organs from functioning. This means that in the school and home the appetites and passions of children may best be reduced, not by laying down rules and preaching to children, but by removing the causes that excite their appetites and passions. If an organic structure begins to be reduced in size as soon as it ceases to function, may it not be that a disposition to lie or steal, or a tendency to outbreaks of temper, can be reduced in the same way? The exercise of continual caution in not tempting children to stubborness, destructiveness, theft, deceit, anger, envy, jealousy, etc., sums up the pedagogics not only of common sense, but also of evolutionary law. That is to say, the moral pedagogy of the first period of life is revealed in Nature's method of disuse and atrophy. *Where function of the immoral diathesis does not occur, reduction*

must inevitably follow. Finally, Nature's third method of elimination is that of the transformation of function. Here is suggested the rational process of moral training during the second period of development, namely, adolescence. This is the period when the whole egoistic nature normally undergoes transformation in the direction of altruism. All the feelings of conjugal, parental, and social affection that the race has built up through sex relationships and the love and care of offspring begin to awaken. The immoral tendencies incidental to such an awakening are peculiarly susceptible to the transforming process, for the very reason that so many healthy and useful directions may be given to the instincts that excite them. This is the period, therefore, for definite moral and religious instruction. Appeals may be made both to the emotions and the reason that would be utterly ineffectual in childhood. Religious teachers have everywhere recognized this fact, and have made the beginning of adolescence the initiatory stage to a religious life. Studies by Drs. Hall, Starbuck, Lancaster, and others, have discovered the psychological rationale of such a method, in the fact that adolescents are normally subject to marked religious experiences. We have here suggested, therefore, the method and the culture-material for adolescent education along moral lines The former is the transformation of the sex-diathesis in the direction of more advantageous functions; and the latter is moral precept and exhortation, and especially religious culture.

But, as we have seen, the elimination of the immoral diathesis is not the entire problem. When immorality becomes persistent and exaggerated into disease, Nature shifts the process of elimination from organs to individuals. Immorality, instead of being a phenomenon of incompleted development, becomes a phenomenon of arrested development and retrogression. It is of course impossible to separate the types of immorality. They blend into one another insensibly. It is therefore also impossible to say when moral education ceases to be effective. Certainly, human effort in this direction should never cease, for here as elsewhere faith should be larger than knowledge. Nevertheless, the cause of moral progress will be furthered by a recognition of the stern truth that moral retrogression, like physical retrogression, may advance so far that the extinction of the individual, community, or race, becomes certain. We know that physical degeneration reaches a point where the individual must perish as such, and where the propagation of offspring is stopped because Nature has rendered him sterile. Every type of monstrosity illustrates this, from hermaphroditism to the forms that are so misshapen that they cannot survive birth. On the psychical side, idiocy and insanity are illustrative; as

are also the graver moral delinquencies, such as drunkenness and licentiousness. Paul declared: "Neither fornicators . . . nor adulterers . . . nor abusers of themselves with mankind . . . nor thieves . . . nor drunkards, shall inherit the kingdom of God." The testimony of the scientist who has investigated the laws of organic and psychical development is not less emphatic.

Without, therefore, discarding indiscriminately the moral agencies that are at present employed in dealing with the worst types of immorality, is it not time that civilized society should lay the stress of its work upon the larger aspects of social regeneration, rather than upon the minutiæ of individual regeneration? Is it not time that Nature's methods of eliminating individuals as well as organs should be recognized and adopted? If it is the part of parents and educators to assist Nature in eliminating the forms of immorality that are due to incompleted development, why should it not be the part of society to assist in eliminating individuals and stocks in which immorality has become persistent and diseased? This, to be sure, is an enormously complex and difficult problem; but it is one that will sometime have to be met. Its solution must be found along two lines: (1) The removal of vicious and criminal persons from society, and (2) the prevention of propagation of their stock. Both of these methods are recognized at present in the imprisonment and execution of offenders, and in the prevention of idiots, etc., from marrying. But the methods must have a vastly wider application. The vicious and criminal must be weeded out and segregated permanently, and not, as now, for a term of a few years. There is certainly no greater legal travesty than that illustrated by the presence in such countries as England and the United States of thousands of criminals mingling with society, known to the police as "habitual offenders," but unmolested because they have served their "time" and have succeeded in covering up their tracks. Recently, a noted pickpocket known to the police circles of all the larger cities of the United States was seen in a certain city and arrested on suspicion. Nothing could be proved against him, however, and he was dismissed on condition that he leave the town; this, too, in the face of the fact that his picture has been in the rogue's gallery for many years, and that his career since boyhood has been divided between imprisonment and lawlessness.

Again, the vicious and criminal must be prevented from propagating their kind. If nature is busily at work rendering sterile such classes as the drunkards, roués and prostitutes, why should not society supplement the efforts of Nature and complete the process? Here, again, society enacts thousands of judicial travesties yearly in fining such habitual delinquents and then turn-

ing them loose to continue their gratifications of appetite and lust, meanwhile begetting offspring that shall spread the curse of evil into other generations. The segregation of persistent and diseased immorality, therefore; the prevention of marriage among delinquent classes; and, in extreme cases, perhaps, stirpiculture, are the methods that Nature suggests to society in any rational attempt to effect its own regeneration. However stern such methods may seem, and however difficult of application, they are not more stern or difficult than the forces that are everywhere in nature making for progress and against retrogression. Here, as elsewhere, that individual and that society which interprets the laws of Nature and applies them, is not only wise, but is also a benefactor to the present and future generations.

MINOR STUDIES FROM THE PSYCHOLOGICAL LABORATORY OF CORNELL UNIVERSITY.

Communicated by E. B. TITCHENER.

XIX. VISUAL READING: A STUDY IN MENTAL IMAGERY.

By W. B. SECOR, B. S.

INTRODUCTION.

The question before us in the present Study is: Is it possible to read without mentally hearing the words, and without feeling them in the throat, the mouth, or on the lips? Can one grasp the meaning of printed or written matter through the eye alone, without the aid of articulatory or auditory images? In other words: is it possible to pass from the visual word directly to the sense, without the mediation of articulation or audition?

The word as sign of an idea may exist in the mind in four ways: as auditory image, as visual image, and as motor image either hand-motor or articulatory. The four centers in the brain corresponding to the four ways in which a word may exist as an idea-sign are pretty well localized. If we were to judge *a priori*, we should say that two of these centers, namely the auditory and articulatory, must be more firmly organized and better correlated than the other two, inasmuch as they have been in use ever since the race began to utilize vocal signs for communication; the word has been a sound or an articulatory movement for an incomparably longer time than it has been a visual or hand-motor image. What is true of the race is here also true of the individual; the child learns to speak and hear words as words some time before it learns to write or to recognize the visual word. Besides the advantages of priority of development in the race and in the individual, the auditory and articulatory centers have the further advantage of being much more constantly in use with the majority of people than the visual and hand-motor centers. For these reasons, then, one is led to conclude that the auditory and articulatory word must necessarily be a much more persistent and prominent factor in language than the visual or hand-motor word.

This *a priori* conclusion is borne out by the facts gleaned from experiment, and by everyday observation. Three out of four

of the subjects of this Study have both audition and articulation in ordinary reading; the fourth has only audition, but this is very persistent. All said that they usually thought in auditory terms, and some have the articulatory accompaniment as well. On the other hand, none of them see words (have the visual word) when thinking or when talking.

It is a significant fact that the subject who seems to be most predominantly visual has had the greatest difficulty in deciding whether she does or does not see the word while talking. When conscious of being under experimentation, she always sees the words as they are spoken. The method employed here was to induce the subject to talk, while unconscious of the experiment, and then ask her to introspect as to whether she saw the words as spoken. Invariably, when she was thus asked, the words last articulated would flash before her mind in visual terms. For some time it was hard to discriminate between visualization thus occasioned by the question, and the real composition of the mind during speech. After some practice, however, introspection gave a definite verdict that there was no visual imagery of spoken words. The other subjects, who were not so decidedly visual, said that they never or scarcely ever saw words as they thought or talked; some even found that an effort was required to see the words spoken by themselves, even when they wished to do so. The fact that the subject who was most decidedly visual in type found it difficult to determine whether visual images of words were present during speech, while others of a less decided visual type found little or no difficulty in determining that they were absent, is a useful confirmation of our *a priori* theory. It further shows that the prominence of the visual, auditory or articulatory word depends somewhat upon the type of the individual.

Another element of scarcely less importance than the preceding would seem to enter here. Since, as we have seen, the peculiar prominence and persistence of auditory and articulatory imagery are due to its greater use by the race and the individual, we should naturally suppose that practice or continued use would have the same effect in bringing visual imagery into prominence. This seems to be a correct conclusion: for the degree to which audition and articulation are banished from reading, and the extent to which visual words occur in ordinary talking, appear to depend upon the amount and kind of reading done by the subject. If he has intellectual tastes, and has been accustomed to studious habits and consequently to much reading from youth up, other things being equal, audition and articulation will tend to become less and less distinct and finally perhaps fade out entirely, while the visual word will become more and more prominent. This conclusion is borne out by our ex-

periments, so far as they go, although four subjects could furnish only very meager data for so general an inference. The subject with whom the auditory and articulatory elements were of little importance, and the visual of somewhat more than ordinary importance, was D., a Graduate Student about to take the examinations for the doctorate in philosophy. She must necessarily have done much reading. A second subject, Wh., was a second year candidate for the philosophical doctorate, and had probably read less that D., but much more than the average college student. With Wh. the articulatory element was almost entirely lacking. The visual word was not developed to any great extent; yet he could see the words spoken by himself, with a little effort. The other two subjects, Wi. and O., a Senior and a Junior respectively, differed but little in the prominence of the auditory and articulatory factors, the articulatory being a little more prominent in the former than in the latter. Neither saw the words that he used, without a considerable effort.

I. Memory Types.

As already indicated, the mental constitution or type of the individual has much to do in deciding the place that each sense shall have as a factor in reading. It is quite important, then, in experiments of this kind, that the type shall be known. The first method employed to ascertain this fact was as follows. (*a*) A word is written on the blackboard by the experimenter, the subject having his eyes closed. At the signal "Now," the subject opens his eyes and looks at the word. The word is then immediately erased and the subject asked to say whether he had auditory and articulatory images of the word, and what further imagery was suggested by the word as a word. We give here replies, one from each of the four subjects, each being as far as possible characteristic. Following this is a tabular form, showing the results as to kind of imagery suggested by the word in each case.

(1) The word "Slate-roof" was placed before Wi. Introspection was as follows. "I heard the word very low, as if spoken by myself. There was a little movement of, or effort to move, the tongue. I saw the top of the Armory with a slate-roof on it, a good distance off. The slate was grey." (2) The word "organ" was presented to Wh. Introspection was as follows. "I heard the word but had no articulatory feeling. I started indistinctly to visualize a general organ in front of me, then I had the sensation of turning towards the Chapel, and visualized the organ there. I heard some notes in the sound of my own voice, like *too, too, too, too.*" (3) The word "steam-whistle" was presented to D. Introspection was as follows.

"I had no articulatory or auditory images of the words: the meaning just came from seeing the word. First I heard the high, shrill whistle of a locomotive, then I had a visual image of the whistle with the steam all around it, as it is sometimes seen. In the background was a locomotive, very ill defined." (4) The word "Ink-stand" was presented to O. He introspected as follows. "I heard the word, and there was a slight articulatory feel on the end of the tongue. A glass ink-stand flashed before me, about arm's length away."

The imagery of the different subjects was studied by another method also. (*b*) Each was asked to reproduce the matter read in the experiments presently to be described, and then to tell just how he reproduced, *i. e.*, whether in auditory terms, visual terms, etc. This experiment, as well as throwing light upon the type of the subject, was a means of assuring the experimenter that the subject had actually read the paragraph assigned rather than merely glanced it over.

The first experiment, in which the words were presented, showed all four subjects to be of a decided visual type. Both the methods showed D. to be distinctly visual in type. The visual images were not especially clear-cut, but they were profuse and detailed, *i. e.*, all parts of an object or scene had their counterparts in the visual image. The image could be recalled and examined at will some time after it had vanished. The subject is able to read from a visualized page, not of course with the degree of surety that would accompany the reading of a real page, but still with tolerable accuracy. She sometimes reproduced short paragraphs in this way. The usual way of reproduction in such cases was, however, to reproduce from the visual pictures formed when reading the paragraph, with aid also from various visualized words. This subject, as we have said, was the most decidedly visual of the four.

The next in order was Wh. His visual imagery was as clear-cut, perhaps, as that of D., yet it lacked the detail and profusion. In his imagery in general he drew upon more senses than the others, *i. e.*, his type was more mixed.[1] Notwithstanding the fact that he was decidedly visual, he had a strong tendency to be ear-minded. He usually heard as well as saw that which was suggested by a word, the visualization invariably coming first, however. In reproducing the paragraph Wh. depends mainly on the visual picture, the visual word and the

[1] Wh. differs from D. in having more images as regards variety, but less profuse and detailed imagery as regards quality. It would be a very interesting study to determine whether there is any special relation of dependence between these two factors; to ascertain, *e. g.*, whether detail is inversely proportional to variety of imagery, as this instance seems possibly to indicate.

TABLE OF IMAGERY.[1]

WORDS SHOWN.	D.	WH.	W.	O.
Driftwood	V	V	V	
Waves	V	V	V	
Violet	V & M	V	V	
Book	V & P	V	—	
Salt	Gus & V	Gus. V. M.	V	
Quail	V & A	V	Gus. & V	V
Sea-shell	V	V & A-verb	V?	V
Waterfall	V	V & A	—	V
Rose	V	V & olf. ?	V	V
Wet sidewalk	V & M	V & org.	V & olf.	V
Railroad	V & A	V	V	—
Springtime	V	V	—	V
Infinity	—	—	A-verb	V
Fog	V	V & org.	V & A & A-verb	A & A-verb & V
Dog	V	V	V	V
Leaves	V	V & A & A-verb	V	V
Expanse	V	M & V	V	—
Bright day	V	—	V & A?	—
Brimstone	V		—	V
Forest	V	V	V	V
Whistle	V & A	A	V	A
Summer night	V & olf.	A & T	V & A & A-verb	V
Steam	V	V & A	V & A	V
Picnic		V	V	V
Fog-horn		V	—	V
Landscape		—	V	V
Fire		V & A	V & T	—
Blackbirds		V & A	V & A	V
The morning wind		A & V	V & A	A
Glowing horse shoe		V & A	V	V
Flute	A & V	V. M. A.	—	A & V
Ice-water	T & V	V. M. T.	V	V?
Brass-band	V	V & A	V & A	—
Horse	V	V & A	V	V
Bees	—	—	V & A & A-verb	—
Robin	V & A		V	V
Chimes	V & A		V & A & A-verb	V
Kerosene	V		V & org.	V
Grass	V		A & A-verb	V
Red-squirrel	V		V	V
Skaters	V		V	—
Lamp	V		V & olf.	V
Blue-book	V		V	V
Tobacco	Olf. & V		V & olf.	V
Steel	—		A & A-verb	V
Slate-roof	V	V & A	V	V
Partridge	V	V & A	V	V
Distant bell	V & A	V & A	V & A	—
Street car	V. A. P?	V	V	V
Camphor	Olf.	V. M. olf.	V	V
Knife	V	V. M. A.	V	V
Cigar	Olf. & V	V. P. gus.	V & gus.	V
Sandy bar	V	V. A. T.	V & A & A-verb	V
Deep-voiced ocean	A & V & A-verb	A & A-verb & V	V & A	V
Forest primeval	V	V & A & A-verb	A & A-verb	V
Piano	V	V & A	V	V
Steam	V. A.	V & A & P	V	V
Valley	V. A.	V	V	V
Envelope		V. A. M. gus.	V	V
Lavender		A & A-verb V	V	—

[1] In this Table, V = visual; A = auditory; M = muscular; T = temperature;

TABLE OF IMAGERY.—*Continued.*

WORD SHOWN.	D.	WH.	W.	O.
Rising tide		V & A	V	V
Watch	V & A	V & A	V	V
Sleigh-bells	V. A.	A & V	V	A
Key	V	V & M	V	V
Engine	V & A		A & V	V
Violin	V & A		V & A	V
Headache	S	V	—	—
Organ	V	V	V	V
Bicycle	V & M	V & M	V	V?
Chickadee	V & A	V & A	V	—
Steam-whistle	A & V	V & A	V	—
Ink-stand	V & G	V	V	V
Light	V	—	V	—
Smoke	V		V	V
Soldiers	V		V	—
Darkness	V		—	—
Postage-stamp	V		V	V
Church-steeple	A & V		V	V
Umbrella	V		V	V
Box	V	—	V	—
Child	V	V & A	V?	V
Empty barrel	V	V	V	V
Flies	V & A			
Foot-ball	V & A			
Clock	V			
Machine	V & A			
Eye	V			
Xylophone	V & A			
Trench	V			
Newspaper	A & V			
Sparrow	A & V			
Hen	V			
Tennis court	V & M			
Field of grain	V			

S = strain; olf. = olfactory; org. = organic; P = pressure; gus. = gustatory; A-verb = auditory-verbal. A blank space indicates that the word was not shown to the subject in question; a — that introspection revealed nothing but visual-verbal elements.

accompanying auditory word. Wh. is a musician, and sings as well as plays. He says that he invariably has a tune in his head when not engaged in serious study or thinking; he sometimes chews in time with a tune when eating.

Both methods show Wi. to be a visual, yet he depends on other senses to some extent. In reproduction the visual picture suggested by the sense is the main factor; he is, however, assisted by visual words. The words thus visualized are always heard as well as seen. His images are fairly clear and well defined. They are not especially detailed or profuse.

The experiment in which words are presented shows O. to be a visual, yet his visual images are indistinct and ill defined. He often visualizes pictures of objects rather than the objects themselves. In the reproduction of matter read, visual pictures do not play an important part; in fact they are almost entirely absent, and he says that he reproduces from the "sense." He seems inclined to identify 'sense' with audition, and to say that he reproduces in auditory terms. He always, however, gives back the paragraph in his own words rather than in the

words of the book: which suggests that auditory images are not really a prominent factor in his reproduction. It is quite probable that his mode of reproduction is very complex, being composed of elements from many of the senses. These elements by use have become so fused and knit together that the resulting complex seems like a unity, which does not resemble the imagery of any one sense, and can be given no better expression than by the phrase 'reproduction from the sense.'

II. Reading by Vision Alone.

In attacking the problem of the possibility of reading without articulation and audition, two general methods are available. One might try an indefinite number of people until one or more should be found who could read without the articulatory or auditory accompaniment; or one might select three or four subjects, and, placing them under conditions which would tend to decrease or fade out the auditory and articulatory elements, so train them that it should become possible for them to read by the aid of the eye alone. Either method, if pursued far enough, would furnish a solution of the problem. The former, however, hardly seems practicable. Too much time would be required to train each subject to introspect well enough for scientific purposes. And, even were this time at our command, it would be difficult to obtain the required number of subjects. Moreover, there is a bare chance that reading without audition and articulation is possible, and yet that no one under ordinary conditions would read in that way. The second method is, therefore, the one followed here.

The nature of the problem makes it difficult to use any but general checks upon the pure method of introspection. Hence, with one exception which will come out later, the results here recorded are the product of introspection under general control. The subject performed the experiment as directed by the experimenter, and then gave his introspection in answer to various questions, which were calculated to bring out the information required. Great care has been taken to avoid what sometimes occurs in the act of introspection, the reading into the introspection of that which occurs after the experiment is concluded, and at the time of introspecting, rather than the giving a true account of what happened when under the conditions of the experiment.

(*a*) The first specific method employed was as follows. The subject was given a book and asked to read a certain paragraph as rapidly as possible. This was with the expectation that the eye would outrun the ear, thus leaving it behind, and allowing the auditory element to drop out. The method was varied by asking the subject to read the first part of a paragraph at ordi-

nary speed and the latter part as rapidly as possible and *vice versa*, thus making possible a comparison between the imagery aroused when reading at the normal speed, and that aroused when reading at the maximal rate. The results obtained were fairly constant with three subjects, but varied with the fourth. With the three, the audition and articulation were less prominent than in ordinary reading. They were less prominent, because a less noticeable factor in consciousness. Two of these subjects (O. and Wh.) say that some small words are not heard at all, and that others are not heard distinctly. Besides this general tendency to fade the images seen in rapid reading, O. and Wh. find another difference. They hear the words in each case about as they would articulate them. When reading slowly there is plenty of time for full round articulation, but in rapid reading the words are heard as slurred and indistinctly pronounced, as when talking rapidly. With D. rapid reading fades both audition and articulation, the latter sometimes being absent altogether, while the former becomes a very indistinct factor. Wi. finds that, when he is trying to hurry the reading, the auditory element becomes more distinct and noticeable; the articulation, however, sometimes becomes less distinct. On the whole, then, the general tendency of the method seems to be to make the auditory and articulatory factors more indistinct. In no case has it succeeded in banishing the auditory element; but, on the other hand, Wi. O. and D. often say that they had no articulation.

(*b*) The second method employed was calculated to shut off, if possible, the articulatory element, while it also affected audition. The method was as follows. The subject was asked either to say the alphabet aloud or to whistle a tune while reading. The results of this method were somewhat startling. It completely removed all traces of articulatory movement, so far as the possibility of discovering this by introspection is concerned. All subjects throughout the year, with very few exceptions (D. thought a few times that there was a slight tendency to articulate, but by far the great majority of her judgments say that there is no articulation), found no articulation present under these conditions.

It was thought that there might be certain articulatory movements during the intervals in which the organs were not occupied in forming the letters or the tones, and that on account of the general articulatory movement, accompanying the saying of the alphabet or whistling, these interstitial movements would be overlooked by introspection. To guard against this, the method was varied by asking the subject to read while articulating a certain letter, prolonging the letter as much as possible. The results only verified those of the original method. Artic-

ulation was completely eradicated. The method was varied still farther. To ascertain whether conscious voluntary movement of any part of the body might not remove the tendency to articulate, in the same way as the above method,—or at least produce the same apparent result by distracting the attention, thus showing the first results to be a mere distraction of attention, rather than a removal of the tendency to articulate,—the subject was asked to clap the hands, swing the feet, trot the foot, etc., while reading. These movements did not seem to interfere in the least with the articulatory tendency. The result indicates that the results obtained from the two former methods were not merely apparent but real.

The Verdin laryngograph was now applied to the throat, as a check to the introspective method in its application to articulation. This instrument indicates movement of the larynx by tracing a curve on the kymograph cylinder. It can, of course, detect only actual movements of the larynx and movements of some magnitude; it cannot indicate subliminal movements, or the presence of a purely mental articulatory image. The laryngograph was supported from the chest, so that the breathing movements caused the pointer to trace a regular wave-like curve on the cylinder even when there was no movement of the vocal organs. The method first pursued was to obtain a breathing curve, and then lower the cylinder and trace another curve just above the breathing curve, the subject reading silently while this second curve was being traced. These two curves, one above the other, enabled the experimenter to compare the one with the other, and detect any irregularity indicating movements of the larynx. It was soon found that, although the instrument allowed itself to be adjusted so that very slight movements could be detected, it was very hard to determine just what irregularities of the curve were the result of articulatory movement proper, and just what were due to some accidental movement of the subject. A method which should allow for more precision and certainty was therefore necessary. The following method was then devised. After tracing the breathing curve, the cylinder was lowered, and a curve was traced just above it while the subject read aloud in time with a metronome, reading one word at each beat. The cylinder was then again lowered, and the subject read silently the same matter as before in time with the metronome,—thus tracing a third curve above the other two. The part of curve 2 which represented the articulatory movement for any word had its duplicate in the curve above, in case there was any articulatory movement when the subject read silently. This made the detection of any movement of the vocal organs a fairly simple matter; yet the

reading in time with the metronome favored articulation, rather than tended to check it.

The results of the laryngographic test correspond very well with the introspection of the subjects. With Wh. and D. the curves show no articulatory movement. Wh. never finds any articulatory tendency when he introspects, while D. never finds movement, but sometimes has the articulatory feel. The curve indicated movement in the case of Wi. and O. Wi. is a mouth reader, and almost always finds articulation present when he introspects; while O. finds articulation present to a greater or less extent.

The success in shutting off the articulatory element, by the occupation of the articulatory centers with other stimuli, suggested the idea that the auditory factor might be eliminated in a similar way. The method was this. (*c*) The subject read a paragraph while whistling or saying the alphabet, and the experimenter played on a xylophone at the same time. The experiment was intended to shut off both articulation and audition. The results, though not so startling as those of the former method, are nevertheless quite decided. D. found that both articulation and audition were usually absent when she read under these conditions; that the meaning came as a direct result of the visualization without the mediation of auditory or articulatory elements. Wh., in whom articulation is invariably absent, and audition invariably present, finds that his auditory images are a much less distinct and noticeable element, when reading under these conditions. They do not seem as loud and do not occupy as prominent a place in consciousness as ordinarily. The results obtained from O. are very similar to those from Wh., except that, while ordinarily having articulation, he now finds it absent. Wi. finds the articulatory element eliminated, but the auditory still persists with as much vigor and force as ever.

The methods thus far described are those which were the most fruitful. Another, employed as a possible check upon the foregoing, was suggested by Dr. T. L. Smith, who was experimenting at the time upon a cognate problem. It takes advantage of the fact that there are certain classes of consonants whose formation requires distinctly different positions of the vocal organs (dentals, labials, gutturals). The subject was seated before an exposure-screen, with eyes closed. At a signal the eyes were opened to see a letter exposed on the screen. Shortly (1-1.5 sec.) after the signal for opening the eyes was given, and at a moment when the subject would have had about time to apperceive the letter, the experimenter pronounced a word containing an initial or final consonant taken from the same group as the letter exposed (*e. g.*, expose *t* and say *dot;* expose *b* and say *pelt*). This procedure was varied by ex-

posing, for example, a dental, and pronouncing a word beginning or ending with a labial or guttural. The value of the experiment in the present case would lie in a comparison of the introspections under the two different conditions. For Miss Smith had found that when the exposed letter was followed by a word beginning or ending with a similar letter, the subject invariably saw the word pronounced, but with the letter exposed in the place of the true initial or final letter. When, *e. g.*, *t* was exposed, and *dot* pronounced, the subject saw *tot*. On the other hand, when the letter was followed by a word whose initial or final letter belonged to a different class, the subject saw the word pronounced with the exposed letter hovering about in space near the incongruous initial or final. When, *e. g.*, *d* was exposed and *pelt* pronounced, the subject saw *pelt*, but somewhere near the *p* he also saw the *d*. The *d* "seemed to be trying to get into the word." The above are results obtained by Miss Smith from a subject whom we had supposed to be of a practically exclusively visual type. They showed that there was an incipient tendency in this subject to articulate, or at least that there was something besides the visual element as a factor in reading. This element, which had escaped introspection, was discovered by this method. It therefore seemed worth while to employ the same procedure with D., with a view to discovering whether there was with her, too, this other and elusive element in reading. The following are a few of the most characteristic results.

(1) Exposed *d* and said *then*.

"The auditory sensation of the word, and the visual sensation of the letter both came at the same time; then the visual image of the word behind and to the left of the letter, and having no connection with the letter whatever."

(2) Exposed *t* and said *throat*.

"The two sensations (aud. and vis.) came together; then came the visual image of the word, and a visual picture of the inside of the throat. There was no connection between the visual image of the word, and the visual sensation of the letter."

(3) Exposed *b* and said *top*.

"The two sensations came simultaneously; then a visual image of the word and of a top; also the actual image of the feel of a top between the fingers."

These and many similar results show clearly that with D. there was *no* incipient tendency to articulate. In general the letter exposed and the word articulated by the experimenter were separately and distinctly perceived, no relation existing between the two. D.'s introspection, then, is verified by this check.

(*d*) Other methods were used without any decided results that would help in solving the problem before us; *e. g.*, a word was selected from a paragraph and placed on the blackboard.

The subject was asked to look at the word, and then glance rapidly down the page until he found it, getting the sense of the page as far as possible. He then gave his introspection and stated whether he had any auditory or articulatory images of the words glanced over. Little resulted from this method, except that the word was usually found before the subject had reached it in reading. This shows that the eye is appreciably ahead of the sense in reading, a fact which has been pointed out by others.

To see what effect a strange or new element in the kind of letters used would produce, the subject was asked to read matter in which the long S was used. Three of the subjects had distinct auditory images of a sound which is a cross between an S and F, a sound like the lisped F. The fourth subject did not have this experience, but sometimes read the S as an F, and had to reread to correct the error.

There are certain conditions under which the articulatory, auditory, and visual imagery are much more distinct than usual. When the subject for any reason stumbles on a word, and has difficulty to grasp it at first, or tries to read a foreign word, the articulatory and the auditory imagery are much more marked; they seem to serve as aids to overcome difficulties in obtaining the sense. In reading dialogue the auditory element is more distinct than usual, with some subjects. The visual imagery of italicized or capitalized words is more persistent than it is for words not thus made conspicuous.

Summary.

The results of these experiments as a whole are as follows:

(1) The auditory element is a much more persistent factor in reading than articulation.

(2) Both articulation and audition are to be regarded as aids in reading, rather than absolutely necessary elements.

(3) The prominence of the auditory and articulatory elements in reading depends upon the type of the individual, and upon the amount and kind of reading done by him.

(4) It is possible to read without articulation and audition.

MINOR STUDIES FROM THE PSYCHOLOGICAL LABORATORY OF CLARK UNIVERSITY.

COMMUNICATED BY EDMUND C. SANFORD.

XV. AUTOMATIC MOVEMENTS OF THE LARYNX.[1]

By H. S. CURTIS,
Sometime Fellow in Psychology, Clark University.

Automatic movements of the hand are demonstrable in many normal subjects, and with a little cultivation can be brought nearly or quite to the verge of automatic writing.[2] What is true of the hand is of course measurably true of other members, the chief requisites being, apparently, a high degree of mobility in the member and a temporary abstraction, or at least inattention to it, on the part of the subject. These requirements are very well fulfilled by the vocal mechanisms, which are, perhaps, the most mobile in the body, and at the same time are out of the visual field, and function with a minimum of direct attention. A further interest attaches to their activities on account of the large part which language plays in the ordinary course of thought. The experiments of Hansen and Lehmann[3] show clearly the tendency of these organs to automatic activity, and the experiments about to be described add confirmation. The chief interest of the latter, indeed, lies in showing that such movements are very common with normal people, and are comparatively easy of demonstration.

The essential part of the apparatus used was nothing more than two tambours: a receiving tambour applied to the larynx, and an inscribing tambour writing upon the smoked surface of

[1] The experiments recorded in this paper were made in the spring of 1897.

[2] Binet: Double Consciousness in Health, *Mind*, XV, 1890, 46–57. Jastrow: A Study of Involuntary Movements, *Amer. Jour. Psy.*, IV, 1892, 398–407; V, 1892, 223-231. Tucker: Comparative Observations on the Involuntary Movements of Adults and Children, *Ibid.*, VIII, 1897, 394-404. Solomons and Stein: Normal Motor Automatism. *Psy. Rev.*, III, 1896, 492-512. Stein: Cultivated Motor Automatism, *Ibid.*, V, 1898, 295-306.

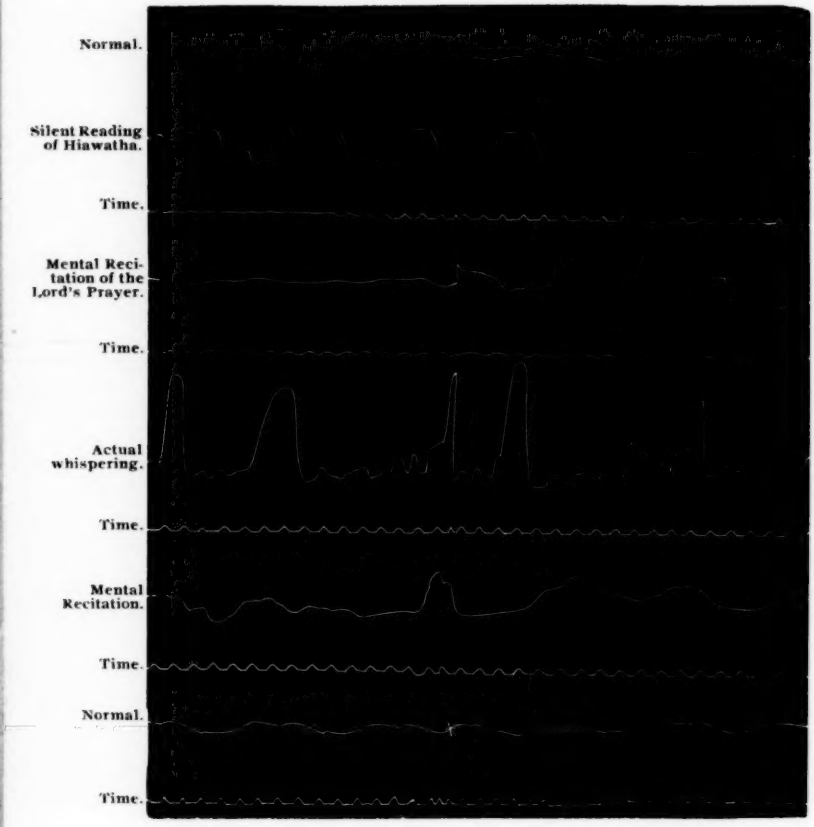
[3] Hansen and Lehmann: Ueber unwillkürliches Flüstern, *Wundt's Philos. Studien*, XI, 1895, 471-530.

a kymograph drum. The inscribing tambour was of the ordinary Marey pattern; the receiving tambour was a home-made one of about the same size, on the rubber face of which a cork —trimmed to receive the tip of the larynx—had been fastened with rubber cement. The rubber face of this tambour had been further stiffened (as in other of the Marey instruments) by a weak spiral spring within. In order to hold this tambour in place against the larynx it was necessary to provide a special means of support. This was secured as follows: Two brass rods were fastened on the sides of an old stiff hat in such a way that they came down beside the cheeks of the subject when the hat was on his head, and extended below the level of his larynx. These were connected near their lower ends by a cross rod securely clamped to both. To this cross rod was clamped in turn a thin lead rod, near the end of which the receiving tambour was fastened, the lead rod, by its partial flexibility, making the regulation of the pressure of the tambour on the larynx fairly easy.[1] During the experiment the subject was comfortably seated in a reclining-chair with his head supported. On the drum a time curve in half seconds was traced by a third and independent tambour.

The usual course of experimentation was as follows: The subject having taken his place in the chair and the apparatus being adjusted, he was told to remain passive and avoid mental effort (or sometimes to keep his thought as much as possible in visual images) while a "normal" tracing should be taken. He was next asked to recite some familiar poem mentally, (or the Lord's prayer, if no poem was in mind,) while a similar tracing was taken for comparison. He was then asked to whisper the same selection, and tracings of this and of other variations of the task were taken till the drum was full. In some cases tracings were also taken when the subject read to himself from a book mechanically supported at the proper distance from his eyes.

In the accompanying plate is reproduced a portion cut from a sheet of such tracings. The curves read from left to right and were taken in pairs (time curve and larynx curve) successively from the bottom upward. Beginning at the bottom the first pair shows a "normal" curve in which the irregularities are due chiefly to pulse and respiration. The crowding of the points in the time curve about midway of the portion shown betrays a tendency of the drum to stick at that point—a matter

[1] The apparatus was evidently rough, but, as it was thus calculated rather to fail in recording the finer laryngeal movements than to exaggerate them, such records of movements as were obtained are not invalidated by it.


Normal.
Silent Reading of Hiawatha.
Time.
Mental Recitation of the Lord's Prayer.
Time.
Actual whispering.
Time.
Mental Recitation.
Time.
Normal.
Time.

of no special importance here, but one that would have to be taken into account in any minute study of the curves. The second pair shows the greatly increased laryngeal movements accompanying mental recitation of a portion of a poem. The third shows the still greater disturbances accompanying whispering. The fourth pair is interesting as showing how the laryngeal movements vary with the energy of the inner speech. Up to about the middle of the portion shown the curve is indistinguishable from a "normal," beyond this point the effects of the laryngeal movement are very marked. During the first part the subject was repeating the Lord's prayer to himself in a perfunctory way without thinking what he was doing. It then occurred to him that, perhaps, this was not what the experimenter wanted and he thought of himself as repeating it before an audience at church; with what result is evident. The fifth pair shows the curve obtained from silent reading in "Hiawatha," and the last (single) curve is a final "normal." The subject was for the most part unaware of the movements of his larynx during the taking of the tracings of inner speech, noticing them but "once or twice."

It is only fair to say that the tracings shown in this plate are not average tracings, but are selected as showing the differences in question in a decided manner; they are not to be regarded as unique however. Forty sittings were taken in all, with twenty different subjects. Of these, sixteen were university students, three were boys between fifteen and nineteen years of age, and one was the university mechanic. Of the forty sittings, eighteen show clearly marked automatic movements of the larynx in some or all of the tracings; eleven show smaller but still distinguishable variations; while the remaining eleven show hardly any difference between the "normals" and the other curves. Of the twenty subjects, fifteen show automatic movements. Four of the remaining five do not show movements even in whispering, and so could hardly be expected to show them with wholly silent speech. The remaining subject served but a single time and tried successfully to suppress all movements. The extent of the movements differed considerably, not only from subject to subject, but with the same subject at different times, being hardly distinguishable at one time and fairly marked at another—a result attributable in part to the difficulty of getting the receiving tambour properly adjusted and partly to different conditions in the subject himself, especially to the energy of his mental speech.

Taken together with the experiments of Hansen and Lehmann these experiments seem to put it beyond question that automatic movements of the speech organs do take place and are far from uncommon.

XVI. Zöllner's Anorthoscopic Illusion.[1]

By Colin C. Stewart,
Sometime Fellow in Biology, Clark University.

In 1862 Zöllner described a modification of the anorthoscope consisting merely of a sheet of stiff black paper in which had been cut a slit of about two by forty millimetres, and a strip of white cardboard upon which any simple geometrical figure had been drawn.[2] By passing the white strip rapidly to and fro behind the slit the figure (a circle for example) is compressed laterally. Very slow rates give a corresponding lengthening of the figure. This illusion he distinguishes from those of the anorthoscope proper—where the distorted figure is merely a summation of a series of partial views of the true figure.

Helmholtz, in correspondence with Zöllner, and later in his Physiological Optics,[3] suggested a physiological explanation for the lateral compression with fast rates, and a psychological one for the extension with slow rates. In his opinion the first is due to a movement of the eyes in the same direction as the figure, which would bring the experiment under practically the same principle as the ordinary anorthoscopic illusion, and the second depends upon the well known principle of the overestimation of small angles. Zöllner prefers a different psychological explanation in the second case, and points out that a psychological explanation is also probable for the illusion in the first case if it can be established that eye-movements are not concerned. To demonstrate this he placed a small mark half way up the slit, and made the experiment while the eyes were held steadily on this point. The result was the same as with free eyes. The illusion in the first form is obtained also, he says, with rates so slow that the question of after-images cannot be involved. He is, therefore, inclined to believe that the double illusion is due to an underestimation of fast rates, and a corresponding overestimation of those that are slow.

The illusion and the rival methods of explanation are interesting enough to invite a reinvestigation. A first step is, of course, to simplify the conditions and, in particular, to substitute a uniform movement in one direction for the variable to and fro movement of the hand apparatus. This was accomplished by drawing the figures upon a continuous band of paper

[1] The experiments here described were made in the fall of 1896 and spring of 1897.

[2] Zöllner: Ueber eine neue Art anorthoskopischer Zerrbilder, *Poggendorff's Annalen*, CXVII, 1862, pp. 477-484.

[3] Helmholtz: Physiologische Optik, 2 te Aufl., p. 749.

carried on cylinders driven at a fairly constant rate.[1] The illusion was found to persist in unmistakable force and with fixed as well as free eyes. Indeed, the usual posture of observation taken by the subjects of their own accord consisted in fixation of the edge of the slit where the figure disappeared. Zöllner's explanation seems quite safe from attack on this ground.

A natural second step, and one suggested by Zöllner himself, is a quantitative study of the illusion. This is particularly interesting here, because the reversal of the illusion with the change from fast to slow rates promises an intermediate rate at which there should be no illusion—a rate, if Zöllner's explanation of the illusion is correct, which would be estimated without error. In order to avoid certain special factors of illusion which attend the use of a circular figure, a solid black square, 47 mm. on a side, and moving in the direction of one of its sides, was employed. Determinations were made for three widths of slit, 5 mm., 20 mm. and 47 mm. and for three rates of motion, 2.2, 4.9 and 25 cm. per sec. Thirteen subjects gave estimates of these nine cases, estimating each a single time, and nine of the subjects repeated the estimate a second time. The estimates were indicated by the subject on a suitably shaped strip of cardboard—not given in figures.[2] The first half of the following table gives the averages of the first estimates of the thirteen subjects; the second half the average of the second estimates of the nine subjects that made them.

	Rate.	25 cm.	M. V.	4.9 cm.	M. V.	2.2 cm.	M. V.
Aperture.	5 mm.	20.7	8.0	59.3	12.2	70.9	13.3
	20 mm.	29.5	4.4	54	6.3	60.5	8.5
	47 mm.	42.4	2.8	47	1.5	47.6	1.4
Aperture.	5 mm.	24.7	7.2	58.5	11.9	68.6	13.2
	20 mm.	34.0	3.8	55.4	4.8	65.3	9.9
	47 mm.[1]	44.1	1.6	51.0	4.3	50.0	4.0

[1] Estimates of 8 subjects.

Though the figures are rough as might be expected from the

[1] The driving power used consisted of the clock-work and weights of the large Krille Chronograph (pictured and described in Wundt's *Physiologische Psychologie*, 4 te Aufl., II, 338 ff). This, unfortunately, does not, at least in the example in the Clark laboratory, give a wholly uniform rate of movement. The variation was not sufficient, however, to affect the general results of the experiment.

[2] [A possible exception to this is when the subject reported the figure as "square" without using the card. E. C. S.]

combination of the estimates of different observers, the general results are perfectly clear. The extent of the illusion diminishes as the width of the slit increases, and is almost wanting for a width of slit equal to that of the square (47 mm.). It is also probable, though it would need a more varied series of rates to prove it absolutely, that the illusory effect increases as the rate of movement changes in either direction from an indefinite medium rate. This medium rate, at which the illusion should vanish, appears to depend somewhat upon the width of the slit, but is something over 4.9 cms. per sec. for slits 5 and 20 mm. wide.[1] It is interesting to notice also that the mean variation of the estimates increases as the slit is made narrower, showing that the subjects vary more among themselves as the illusion becomes more marked. These relations accord with Zöllner's explanation: As the slit is narrowed the opportunity for estimating the rate becomes less and the possibility of illusion is increased; as the rate varies from a certain medium rate it is more apt to be misjudged; as judgment becomes more difficult individual variations are more apt to occur.[2]

It may be asked, however, whether there is any other evidence than that furnished by this illusion that rapid rates of movement are underestimated and slow rates overestimated. In reply it may be said that there seems some reason to believe that there is a general tendency to assign to ill-sensed quantities a medium rather than an extreme value, but this has not yet received the study that its importance as a psychological principle deserves.[3] But irrespective of this general principle it seems to be a fact that such tendencies are active in our judgments of rate of movement, as is strikingly shown by an analogous experiment in the field of passive touch, where erroneous judgment seems to be the only possible explanation. The experiment is given by Loeb in his paper on the Tactual Space of the Hand, and is in the last degree simple.[4] A string is drawn, at different rates of speed, between the thumb and index finger of a subject who presses it lightly and judges its

[1] All of the rates used were much less than the rate found by Lamansky for the rate of the eye's own movement—(*Pflüger's Archiv*, II, 1869, 418-422); so that the rate most correctly judged is probably not a function of the eye's own rate; unless, indeed, the eye's rate is materially slower for short movements than for long.

[2] By judgment, is here meant, of course, not full and conscious logical inference, but the same sort of perceptive inference that is used in seeing form by means of the distribution of light and shade, or distance by the size of known objects.

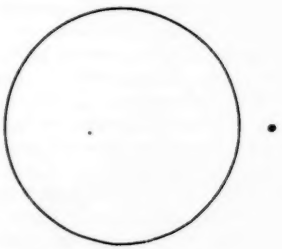
[3] Leuba some years ago noticed something similar in sense memory. *Amer. Jour. Psy.*, V, 1892–93, 382 ff.

[4] Loeb: Untersuchungen über den Fühlraum der Hand. *Pflüger's Archiv*, XLI, 1887, 107-127.

length without the use of his eyes. If the string is drawn slowly it is overestimated, if rapidly underestimated.

The explanation of the illusion by the general underestimation of rapid rates and overestimation of slow ones does not exclude the subordinate co-operation of other influences. It was found, for example, that with rapid rates the "after-image of movement" appeared clearly in the portion of the visual field corresponding to the slit. If this after-image could, to any degree, neutralize the perception of the actual movement, it might furnish a reason for the underestimation of the rapid rates.

A more certain factor is the distortion due to indirect vision.[1] Such a figure as the following will serve as an illustration:



On fixating the point the side of the circle next the fixation point will appear flattened, while the opposite side is more or less indistinct. With the figure passing alternately to and fro behind a slit, as in the hand apparatus, the flattening would occur on both sides, and the result would be a general impression of a laterally compressed ellipse. With the mechanical apparatus the flattening of the side next the fixation point may be obtained if merely a fine white thread, with a black knot for a fixation point, be hung before the travelling paper, the circle clearly seeming to change form as it passes from one side of the thread to the other. The flattening from this cause is too slight, however, to account for that observed in the original experiment, and the chief factor remains the false judgment of the rate of movement.

[1] *Cf.* Helmholtz, *op. cit.*, p. 697.

XVII. Experiments upon the Control of the Reflex Wink.

By George E. Partridge,
Sometime Fellow in Psychology, Clark University.

The best description of the problem of the following study is the incident that suggested it. A party of visitors was standing before one of the snakes' cages in Central Park, New York, watching the cobras strike against the glass. One of the party noticed that every one jumped back when the snakes struck. After their attention had been called to the involuntary movements several tried to hold the face near the glass and to prevent the reflex start, but none could control it. Doubtless with sufficient practice all or nearly all would have succeeded, but the psychophysical problem remains of how they would have attained their success—a problem of obvious importance for both psychology and pedagogy. After considerable preliminary experimenting the control of the reflex wink was finally selected as presenting the same general problem, and special apparatus was devised for exciting it. The first arrangement was as follows: The subject was seated with his forehead and chin supported by a suitable head rest. Close before his face was brought a framed piece of thick plate-glass about six by eight inches in size. On the back side of this glass and attached to the lower side of the frame was a small rubber-faced wooden-headed hammer which, when released from a catch under the control of the experimenter, was swung suddenly upward, and struck the glass about the level of the eyes of the subject. With the instrument in this form experiments were made on several members of the university and others. In a later form of the instrument, however, the head rest and glass plate were both attached to a graduated steel rod (supported on legs and standing on a table) so that the glass and striking apparatus could be set at any required distance from the subject, while the distance could be read in centimetres. The subjects generally knew the nature of the experiment to be made upon them, and were simply requested to refrain from winking.[1] In the experiments on school children, made with the revised instrument, a

[1] [The stroke of the hammer against the glass was, of course, by no means noiseless, and there was also a little tremor and rattle of the apparatus attending the blow. These must not be neglected in estimating the results of the experiments; indeed, it seems to me that the vision of the swiftly moving hammer was, perhaps, a less important factor in producing the wink than the sound of its stroke on the glass. E. C. S.]

card placed some distance away and at about the height of the subject's eyes, was used as a fixation point.

From the nature of the experiment the operator was obliged to judge for himself not only whether a wink had taken place, but also, after the subject had ceased to wink, whether the control was fairly perfect or merely temporary. In the earlier cases in the schools a good many hammer-strokes were given after the winking had ceased, but as the operator became more expert in recognizing the signs of easy control, the number of such extra tests was decreased. In no case, however, was the testing ended till the subject had been able to inhibit several winks in succession, with the appearance of being able to continue the inhibition indefinitely.

In the experiments with the university men it was soon discovered that there were the greatest differences among normal adults in the power of control of the wink. The earlier subjects were tested with the glass close to the face and without a special fixation point. The lever was released at fairly regular intervals, but of course without warning. Some were able to control the reflex movement after four or five trials and during a long series there was either no trace of movement of the eyelids or only a very slight twitching, unless there was great variation in the intervals between the stimuli; while others were unable to inhibit the reflex even after long practice.

Two subjects who had difficulty in controlling the movement were given long series of tests in order to study the method of control, and its gradual perfection. Both subjects were men trained in psychological work but of nervous temperament. Subject A. was given a series of twenty-nine tests on alternating days, fifty trials in each test. During the first four days no winks were inhibited, and oftentimes the subject winked three or four times after a single hammer stroke. The course of improvement from day to day is shown by the following figures, which give the number of cases in each group of fifty trials in which the wink was inhibited: 0, 0, 0, 0, 5, 6, 0, 6, 11, 5, 10, 10, 17, 17, 32, 21, 21, 15, 26, 16, 41, 16, 22, 23, 15, 27, 21. 32, 25. Summing these in groups of four, gives the following: 0, 17, 36, 87, 78, 102, 95. With this subject the reflex was prevented best by neglecting the stimulus altogether, and not trying to prevent the wink by contracting opposing muscles. He usually fixated some point considerably beyond the glass, and watched it attentively. Change in rhythm of releasing the lever, a peculiar rhythm, or a short interruption in the series, lessened his control. Physiological condititon seemed also to affect the results; after long continued work at his desk his control was lessened.

Subject B. had twenty-seven tests of one hundred trials each.

The number inhibited each day was as follows: 0, 0, 2, 4, 4, 0, 8, 2, 6, 4, 0, 28, 8, 4, 21, 32, 65, 39, 81, 83, 77, 92, 86, 97, 99, 88, 98. Summing these in groups of four gives the following: 6, 14, 38, 65, 268, 352. Subject B. also did best when he fixed his eyes on a distant point and was passive.

Three experiments were made to test the effect of alcohol upon control. A subject who had previously been given ten tests of one hundred trials each, in which he had averaged thirty-two inhibitions, received forty-five grams of alcohol, and five minutes later was retested. Three hundred trials were made in groups of fifty. He winked four times in the first group, but in all other trials the winks were inhibited. On subsequent normal days the subject relapsed toward his former condition. Two tests were also made with intoxicated subjects. Both these showed a decided improvement in control as the effect of alcohol.

After the apparatus had been arranged to allow variation of the distance of the glass from the subject's face the test was made upon upwards of eleven hundred pupils of the Worcester schools.[1]

The method was slightly different from that used with the adults. The child was seated with his face in the head rest of the apparatus and was given thirty-five trials with the plate at the zero point of the distance scale (about five centimeters from the eyes). If at the end of these thirty-five trials the wink was not under control the distance was increased by two centimeters and thirty-five more trials given. Then, if necessary, another thirty-five trials were given at the five centimeter mark, and afterward at 10, 15, 20, 30, 50, 80, 110, and even farther if the reflex had not sooner been brought under control. In this manner was determined for each child the number of winks, necessary before the reflex was mastered.[2] The children ranged in age from five to fifteen years, and included nearly equal numbers

[1] The writer desires to make grateful acknowledgments to the Worcester school authorities for permission to make the tests in the schools, and to the teachers and principals of the schools in which he worked for courtesies received, also to his wife who assisted in the experiments and in the work of tabulating the results.

[2] This method of computation neglects the element of distance in the final results (resting only on the number of winks), but is sufficiently exact for present purposes.

The number of winks was used rather than the number of trials, when the two did not agree, because in this way the child was given the benefit of any scattering successes occurring before he had gained complete control. A record like the following, for example—w w w w w o o o w w o o o o o o o o (w=winks, o=successes)—would stand as a score of 7 against the child when winks are counted, but as a score of 10 when trials are counted. In most cases, however, there was no difference.

of boys and girls: Boys, 584; girls, 557.[1] The following table shows the number of each age tested, together with the least number of winks necessary in any case before control was secured, the median number and the greatest number necessary:[2]

TABLE I.

Showing the Number of Winks Necessary Before the Gaining of Control.

AGE.	BOYS.				GIRLS.			
	TOTAL CASES.	LEAST NUMBER.	MEDIAN.	GREAT'ST NUMBER.	TOTAL CASES.	LEAST NUMBER.	MEDIAN.	GREAT'ST NUMBER.
5	55	1	38	218	52	0	40.5	286
6	53	1	22	199	53	1	27	171
7	48	1	4	326	55	1	13	175
8	50	0	3.5	127	50	1	17.5	378
9	51	1	3	191	52	0	6	315
10	48	0	3	233	49	0	9	291
11	52	0	2	140	47	0	4	248
12	55	1	3	69	53	0	23	335
13	58	0	2	81	55	0	4	221
14	67	0	1	261	54	1	3	325
15	47	0	1	71	37	1	2	105

The table shows a gradual improvement with increasing age, most marked in the first four or five years, an index probably of growing control of the muscular system in general during these years and especially of the reflex mechanism. The improvement is both more marked and more uniform in the case of the boys than the girls, the reason for the difference lying probably in the fuller neuro-muscular training which the average boy receives from his freer life. The most marked deviation from uniform progress is in case of the girls of twelve years. The difference seems too great to be merely accidental, and yet the writer has been unable to discover a satisfactory explanation. That it was not due to the general conditions of the experiment seems clear from the relatively small difference in the case of boys of the same age. If the results are treated by averages instead of by medians the same general relations are obtained, though the irregularities are of course differently

[1] In getting the ages of the children no account of the months was taken. The age called "five" therefore extends from the fifth to the sixth birthday, and, similarly, that called "six" from the sixth to the seventh birthday, and so on.

[2] The median number is found by arranging all the cases in order, according to the number of winks recorded, and picking out the middle number in the series. When the number of cases is odd, some particular number will be found; when it is even, the average of the two numbers nearest is taken instead.

distributed. The average number of winks for the 584 boys irrespective of age is 19, and for the 557 girls 34.

Table II is arranged to show the distribution of cases according to success in controlling the wink. The whole number of cases for each age has been divided into eight groups according to the number of winks made before complete control was secured. The first includes all who winked four times or less, the second those who winked between five and nine times inclusive, the third those who winked between ten and nineteen times, and so on, till in the last group are found those who winked 300 times or more. These figures have finally been reduced to percentages for easier comparison. *B* in each case stands for boys and *G* for girls.

TABLE II.

Showing Distribution of Cases According to Success in Controlling the Wink.

AGE.		TOTAL CASES.	0–4 WINKS.	5–9 WINKS.	10–19 WINKS.	20–49 WINKS.	50–99 WINKS.	100–199 WINKS.	200–299 WINKS.	300–399 WINKS.
5	B	55	20.	10.9	12.7	20.	23.6	7.2	5.4	
	G	52	11.5	9.6	11.5	19.2	26.9	17.2	3.8	—
6	B	53	24.5	15.0	9.4	22.6	15.0	13.3	—	—
	G	53	20.6	16.9	9.4	24.5	18.9	9.4	—	—
7	B	48	56.2	8.3	8.3	18.7	4.2	—	—	4.2
	G	55	32.6	12.6	9.0	18.1	18.1	9.0	—	—
8	B	50	60.	12.	4.	6.	14.	4.	—	—
	G	50	34.	8.	10.	12.	32.	2.	—	2.
9	B	51	62.7	13.7	1.9	11.7	5.8	3.9	—	—
	G	52	46.1	13.4	5.7	13.4	13.4	3.8	1.9	1.9
10	B	48	66.6	12.5	2.0	12.5	2.0	2.0	2.0	
	G	49	36.8	14.2	8.0	8.0	24.5	6.1	2.0	—
11	B	52	75.0	1.9	11.5	7.6	1.9	1.9	—	—
	G	47	53.0	6.3	—	16.9	10.5	8.4	4.2	—
12	B	55	65.4	10.9	5.4	14.4	1.8	—	—	1.8
	G	53	36.0	3.8	7.6	32.2	13.2	3.8	1.9	1.8
13	B	58	75.8	6.8	3.4	10.3	3.4	—	—	—
	G	55	56.3	3.6	5.4	21.8	7.2	3.6	1.8	—
14	B	67	76.1	4.4	2.9	4.4	9.0	1.4	1.4	—
	G	54	55.5	7.4	5.5	18.5	7.4	1.8	1.8	1.8
15	B	47	76.5	6.3	2.1	10.6	4.2	—	—	—
	G	37	70.2	10.8	2.7	10.8	2.7	2.7	—	—

The table shows very well the proportion of those who had difficulty in mastering the tendency to wink, and also the dif-

ference between the boys and girls. The actual number of boys in the first group (four winks or less) is 351, in all other groups 233; of girls in the first group 225, and all other groups 332. As in Table I the boys make the better showing, though individuals of both sexes are found in all the groups.

The children were tested partly in the forenoon and partly in the afternoon, but such differences as appear in the averages do not bring out any certain relation between time of day—to which fatigue might be supposed to be roughly concomitant—and the ability to control the wink. There seems also to be no marked relation between ability to control the wink and ability to take high rank in school work. Special tables prepared to test this relation are quite equivocal.

With the thought of discovering some relation between inability to control the wink and general "nervousness," the teachers were asked to indicate the children regarded by them as especially "nervous." Thirty-six boys and forty-seven girls were thus indicated. When the position of these cases is looked for in the classification of Table II it is found that sixteen of the boys and seventeen of the girls belong to the groups winking four times or less, of which groups they constitute 4.5 and 7.5 per cent. respectively. The remaining twenty boys and thirty girls winked five times or more and constitute respectively 8.6 and 9 per cent. of the whole number showing that degree of control. It would appear therefore that a boy described as "nervous" is rather apt to have difficulty in controlling the wink, but that a girl so described is but little more likely to have difficulty than one described as normal.

A similar question was asked about "dreamy and inattentive" pupils, and seventy-one boys and eighteen girls were so reported. Of the boys, forty appear in the first group of Table II, constituting 11.4 per cent. of the group, and 31 fall in the remaining groups, of which they form 13.3 per cent. Of the girls, seven appear in the first group and eleven in the remaining groups, forming about 3 per cent. in each case; showing little relation in either case between "dreaminess and inattention" and inability to control the wink. The proportion of boys and girls thus characterized by their teachers is, however, an interesting index of sex differences in school life.

The methods employed by the children to prevent the wink were various. In most cases tension of opposing muscles was first employed, the younger children sometimes tensing the muscles of the face, arms, legs and body, and even straining the fingers apart. As control was gained the muscle tensions were, of course, in general more definitely localized and lessened in degree. Many seemed to be unable to watch the fixation point, and such wandering attention was usually associated

with small power of control. In the case of some of the youngest children the effort to refrain from winking itself lapsed unless there was an occasional reminder. In a general way two types of good control could be distinguished, a nervous type with strong reflex tendencies, but equally strong control, and a stolid, fearless and somewhat inactive type with apparently less reflex excitability.

The following miscellaneous observations may also be recorded: Momentary changes in attention frequently inhibited a few winks in a series long before control was finally gained. Smiling seemed to be especially effective in temporarily inhibiting the reflex. Changes of any kind in the environment, as of some one entering the room, opening of a door, an unexpected sound, usually increased the tendency to wink, though in some cases such a distraction seemed to have the opposite effect. Some cases were observed in which, though the first few reactions were very violent, involving muscles of the whole body, final control was sooner gained than in cases where the reaction was less violent at the beginning. There appear to be great differences also in the rapidity of the wink, the eye being closed so rapidly in some cases as to make observation difficult, while in others the closure was noticeably slower.

In concluding, the writer may say that he feels that he has barely broken ground upon a subject of very great interest, and that the method here employed, or some modification of it, can yet be made to yield most interesting results in several other directions.

THE EQUIPMENT OF A PSYCHOLOGICAL LABORATORY.

By E. B. TITCHENER.

In *Mind* for July, 1898, I published a paper, entitled "A Psychological Laboratory," in which I gave a brief account of the plan, resources and aims of the Cornell laboratory.[1] Reference was made in the paper to an 'ideal' psychological labor-

[1] A few remarks supplementary to this paper may be made here. (1) We have found it necessary to exclude blackboards, however patent the writing chalk employed, from all rooms but the lecture and work rooms. The chalk dust is inevitable, and extremely penetrating. (2) All floors but one, throughout the laboratory, are of soft wood, oiled. The exception (hard wood, varnished) has proved unsatisfactory. (3) The dark-room lantern window (p. 319 of the *Mind* article) has been cut, and the arrangement works very well. (4) The direct current leads (p. 319) have been extended to five more rooms. (5) In the *Psychological Review* for November, 1898, Professor Cattell offers objection to some of our arrangements. Thus, he regards the "estimate of $300 annually for current expenses" as "rather extravagant." The objection is surely based upon a misunderstanding. All that my paper says (pp. 326-7) is that it is unsafe to begin the working year with a less sum than $300 in hand,—unsafe to have anticipated the year's income by purchases to the amount of more than $300; while it expressly states, further, that whatever remains at the end of the year goes to the procurement of research instruments. Probably the term 'current expenses,' though carefully safeguarded, proved misleading. Again, Professor Cattell urges the advantage, for research, of small closet-like rooms. Here I heartily agree with him, and, indeed, had previously introduced the feature into some of the lesser laboratories that I have helped to plan. We have, moreover, repeatedly canvassed the question of such rooms for the Cornell laboratory. Unfortunately, the functions of the laboratory are such as to preclude the required subdivision. Again, there *is* an advantage in "setting up all the work on vision in one room"—an advantage so obvious that I am surprised at the objection. The coloring and lighting of the room alone, *e. g.*, would justify the procedure. Again, the objection that a "flock of twenty students" must be driven successively into several rooms presupposes that all students in the drill-course are performing the same experiment at the same time. I should regard this as a mistake, whether considered from the student's or the instructor's point of view. It is not our method. Lastly, the objection that the smell and taste room "is not needed for an hour's instruction in the course of the year" seems to me woefully to underestimate—and the underestimation is not uncommon among experimental psychologists—the place of these two senses in a course of laboratory work. Our taste and smell room is occupied as often and as long as any other of the rooms used in the drill-course.

atory, and to the necessity of our having, some day or other, 'special buildings' for the housing of our instruments. I also expressed the hope of issuing, within a year or two, "a pamphlet containing a full list of the pieces that we [at Cornell] possess, with makers and prices, and stating briefly the results of our experience with them." Although the laboratory is not yet completed upon the twelve-room basis, and although the various schemes thought of for an ideal laboratory have not yet matured into anything that could be put into an architect's hands, it still seems worth while, in view of the interest that the preliminary discussion has aroused, to print our inventory as it stands, and to outline the general conclusions that we have reached concerning the laboratory of the future.

I. *Suggestions towards the Plan of a Psychological Laboratory.* The psychological laboratory should be conceived of as a three-story building, with attics and basement. On the ground floor I should place first, to the right, the large auditorium, a room capable of seating, say, 300 persons. This room should be accessible by a special outside stairway, and also by a passage-way behind the lecturer's table. Across this passage-way should lie the museum room, a room devoted to the display of historical instruments, the storage of the demonstration-pieces required for lecture courses, and the safe-keeping of all apparatus not actually in use in the laboratory. The plan of leaving instruments, that are now lying idle, in the places where they were last used, seems to me to be bad even in a research laboratory, but doubly bad in a teaching laboratory. It relieves the student of the wholesome labor of taking-down and casing, and it inculcates a general slovenliness and lack of method in experimental work.—An elevator should run up and down from the museum room.

The left-hand portion of the ground floor would then contain the library; a seminary room, with the Director's office opening into it; and, if space allowed, a general writing-room. This last is a room in which talking is permitted, and which students would utilize for the writing-up of experimental records immediately after the taking of an experimental series.

The second floor represents the drill-laboratory. For this I can think of no better plan of arrangement than that which I have tried to follow in my own laboratory. For optics, there should be two rooms, light and dark, facing south and north respectively, and the latter divided into antechamber and inner room. For acoustics, there should be one large room, connected directly with a small, dark and (so far as is possible without special construction) sound-proof chamber. For haptics, there should be a moderately sized room, devoted to work on cutaneous pressure, temperature, and pain, and a larger

room for investigations of the movement perceptions. Taste and smell should each have a small room, the latter tiled or glazed, and so situated that ventilation is easy and does not involve the opening of doors or transom-windows into the building. There should, further, be a clock-room, for the time-registering instruments and their controls; and a large room for the investigation of the bodily processes and changes underlying affective consciousness (pulse, breathing, muscular strength, involuntary muscular movement, bodily volume). It would also be necessary, I imagine, to have on this floor one or two small lecture-rooms, and private rooms for the instructors.

The third floor represents the research laboratory. The main feature of this would be a group of a dozen or twenty cells, large enough to take ordinary research apparatus and two persons, arranged round a common court or vestibule. There should also be a series of half-a-dozen small dark rooms (optics). I am not certain whether an attempt should be made to build an absolutely sound-proof acoustics room. There are grave mechanical difficulties, over and above the difficulty of ventilation, in the way. Moreover, recent work has shown that we attend to a given stimulus better if we are under a slight 'distraction' than we do if all distractions are ruled out of the experiment. Unless, then, the sound-proof room be itself an object of investigation,—unless we desire to know, for some definite reason, what consciousnesses occur under soundless conditions,—I incline to doubt the advisability of including this room in the scheme of the laboratory. On the other hand, the acoustics quarter should certainly be isolated by a wide passage-way from the rest of the floor, and by double ceilings from the floors above and below. The remaining space upon this floor would be filled by the clock room, a couple of large rooms kept free for such researches as demanded bulky apparatus (static sense, *e. g.*), and the private laboratories of the officers of instruction.

The attic space could be used for photography, for experimental work upon the smaller animals, and for general storage. The basement would contain the laboratory workshops, and rooms for experimental work upon larger animals. At one corner of the building, and separated by the workshops from the animal quarter, there should be a tiled room for research work in olfactometry.[1] The elevator would pass from the workshops through the museum room to the open court of the third floor.

Such, in the very barest of outline sketches, is my plan for

[1] I am very doubtful as to the position of this room, essential as the room is. Perhaps it should be placed upon the third floor.

the 'ideal' laboratory. Crude as it is, it may, perhaps, serve as a basis for future discussion. Experimental psychology is advancing so steadily along the beaten paths, is developing so many new branches, and, above all, is holding out so bravely against pedagogical and philosophical attack, that the realization of a laboratory on the scale indicated can but be a matter of time.

II. *The Equipment of the Cornell Laboratory.* The following list shows the resources of the Cornell laboratory at the present time. The classification is, to some extent, arbitrary; one and the same instrument may play a part in half-a-dozen different investigations. Where two names follow a number, the first is the name of the inventor, the second that of the manufacturer. In no case does the price given include carriage. All the pieces listed have been tested in the laboratory, either in research or in drill-work; and we are ready, upon personal application, to give the results of our experience with any of them.

A word of caution may, however, be in place here. Existing psychological laboratories bear upon them, very plainly, a personal and individual mark. We shall presently shake down into some sort of uniformity; but at present the range of variation is wide. Hence it will be well for intending purchasers to consult with the directors of two or three laboratories, rather than with one only. For example: the Hering indirect-vision color-mixer, a piece which is hardly ever out of use in the Cornell laboratory, is not used at all in certain other of the larger American laboratories which possess it. So the Ellis-Helmholtz harmonical, an apparatus of capital importance in our eyes, receives but a slighting mention in a recent paper by the Director of the Yale laboratory. On the other hand, I have seen the Baltzar interrupter-clock playing a much larger part in general laboratory economy than it does at Cornell. It will not be entirely expedient, then, to trust to the experience of a single university, unless the course of instruction there given is to be pretty closely followed. With this preface we may proceed to the list itself.

A. Physiological and Psychological Acoustics.

I. Anatomy and Physiology of the Auditory Organ.

1. Large clastic model of human ear. Auzoux. Fr. 200.00
2. Two large plaster models of internal ear of man. Steger. Mk. 20.00
3. Mechanical model of drum-skin and ossicles. Helmholtz. Jung. Mk. 50.00

See also H, III and IV.

II. Auditory Sensation: Intensity.

4.	Acoumeter. Politzer. Meyrowitz.	$2.75
5.	Triple fall-phonometer. Titchener. Willyoung.	$50.00
6.	Quadruple sound-pendulum. Titchener. Francis.	$100.00
7.	Brass piston-whistle for demonstrating proper tone of auditory passages. Vs. 1,024-4,096, in semitones. Willyoung.	$5.00

III. Auditory Sensation: Quality and Clang-tint.

8.	Model of piano key-board, with attachments showing direct clang-relationship. After Mach. Made in Ithaca.	$3.00
9.	Collection of instruments for study of clang-tint: 5 mouth-harmonicas, 1 pan-pipes, 3 jewsharps, 3 whistles, 1 bagpipes, 3 ocharinas, 2 oboes, 3 cymbals.	$7.50
10.	Bellows-table, with regulator, wind-chest and key-board for 13 pipes. Koenig. Kohl.	Mk. 400.00
11.	9 open wooden pipes, with manometric attachments, for use with above: c-c^1 (c^1 duplicated). Koenig. Kohl.	ca. Mk. 60.00
12.	Wind-chest with 2 valves, standard for 2 manometric flames, and rotating mirror. Koenig. Kohl.	ca. Mk. 120.00
13.	9 galvanized iron open pipes: c^1-c^2. Made to order.	$10.00
14.	Bellows-table for 3 reed-boxes. Appunn.	Mk. 120.00
15.	Reed-box, vs. 512-1024 (unit of diff. 4 vs.). Appunn.	Mk. 350.00
16.	Reed-box, with musical intervals, 400-800 vs. Appunn.	Mk. 150.00
17.	Reed-box, giving 9 overtones of C of 64 vs. Appunn.	Mk. 70.00
18.	Reed-box, C of 64 vs. Appunn.	Mk. 24.00
19.	Harmonical, giving 24 overtones of C of 64 vs., and 16 of c of 128 vs. Ellis. Moore.	£10.0.0
20.	Square piano. Bought in Ithaca.	$100.00
21.	Differential sonometer, with key and weights. Marloye. Koenig.	Fr. 112.00
22.	Simple sonometer, with weights. Gillis & Gleeson.	$3.75
23.	12 forks on resonance-boxes: c-e^3. Koenig.	Fr. 485.00
24.	4 forks on resonance-boxes: d^1-b^1. Koenig.	Fr. 140.00
25.	a^1 fork on resonance-box, official French standard. Koenig.	Fr. 35.00
26.	2 c-forks, 128 vs., with riders. Appunn.	Mk. 70.00
27.	4 forks (c^1, e^1, g^1, c^2) on resonance-boxes. Appunn.	Mk. 70.00
28.	7 forks (800-801 vs.) on resonance-boxes. Appunn.	Mk. 96.00
29.	33 forks (2,048-49,152 vs.). Appunn.	Mk. 170.00
30.	11 forks (2,000-45,000), with sliding resonator and ear-tube. Kessel. Appunn.	Mk. 60.00
31.	c^2 fork (512 vs.). Blake. Meyrowitz.	$1.50
32.	'Universal' fork, giving semitones. Ziegler.	$1.10
33.	2 c^2-forks. each	$ .25
34.	2 a^1-forks. each	$ .30
35.	Large fork, 16-25 vs. (C_2-G_1). Koenig.	Fr. 300.00
36.	8 forks, 3,840-4,096 vs. (b^4-c^5), in case, with tripod-stand. Koenig.	Fr. 340.00
37.	Electro-magnetic fork. c^2. Koenig.	Fr. 100.00
38.	Electro-magnetic fork, wet contact. 50 vs. Petzold.	Mk. 80.00
39.	Electro-magnetic fork. 50 vs. Chicago Laboratory Supply Co.	$20.00
40.	Electro-magnetic fork. 100 vs. Koenig.	Fr. 100.00

41. Electro-magnetic fork. a^1. Kohl. Fr. 35.00
42. Electro-magnetic fork. c^1. Kohl. Fr. 40.00
43. 13 wire forks, 8-56 vs., on resonance handles. Appunn. Mk. 130.00
44. 14 cylindrical resonators. Koenig. Fr. 380.00
45. 13 Quincke's tubes. Ziegler. $2.00
46. Apparatus for continuous tone-change, table, 2 cylinders, variator, 4 flasks, compressed air-tank, air-pump. Stern. Oehmke. ca. $100.00
47. Galton whistle. Koenig. Fr. 20.00
48. Tone-tester (differential pitch-pipe). Gilbert. Willyoung. $6.00
49. Siren, with four rows of holes and counter. Dove. Kohl. Mk. 85.00
50. Pendulum, with small fork, for demonstration of tonal after-image. Sanford. Willyoung. $16.00
51. 3 bows, set of piano-hammers, rubber-headed mallet, duplicate rubber hammer, etc., for actuating forks. $5.00
52. Steel vibrator, 4-24 vs. Appunn. Mk. 15.00
53. Xylophone, 2 octaves; with four strikers. $1.50
54. Electric phonograph, with 6-way tube, brass horn, speaker, recorder, 16 records, 24 blank cylinders, etc. Edison. Nat. Phonograph Co. $90.00
55. Foot-bellows for actuating galvanized iron pipes. Eimer & Amend. $8.00

IV. Auditory Perception, Memory, etc.

56. 2 simple metronomes. Petzold. each Mk. 7.50
57. Simple metronome. Willyoung. $3.75
58. Metronome with mercury contacts. Kronecker. Petzold. Mk. 36.00
59. Interrupter-clock, cased. Baltzar. Zimmermann. Mk. 170.00
60. 2 telephone snappers (pony receivers). Queen. each $ .90
61. Time-sense disc (Meumann, old pattern), with attachments to Petzold kymograph. Zimmermann. [New pattern: Mk. 280.00]
62. 4 (old pattern) and 6 (new pattern) contacts, with 4 contact-radii, for time-sense disc. Zimmermann. each Mk. 10 to 21
63. Localization of sound apparatus. Titchener. Michigan App. Co. $16.00

V. Charts, etc.

64. 2 modulator charts. Silver, Burdette & Co.
65. 2 charts, showing differences of temperament and vibration ratios of medical intervals. Made in Ithaca. Framed.
66. Chart to illustrate Ellis Harmonical. Framed.
67. Tableau général des nombres des vibrations de la série des sons musicaux. Koenig. Framed.

See also H, IV.

B. Physiological and Psychological Optics.

I. Anatomy and Physiology of the Visual Organs.

1. Large clastic model of human eye. Auzoux. Fr. 75.00
2. Ophthalmotrope. Helmholtz. Krille. Mk. 64.00
3. Two dissections of eye of bullock.

4. Test-cards for astigmatism. Green. Queen. $5.00
5. Test for acuity of vision. Thomson. Queen. $1.50

See also H, III and IV.

II. Visual Sensation: Intensity.

6. Working model of photometer. Bunsen. Gillis & Gleeson. $1.70
7. Large photometer. Bunsen. Made in Ithaca. $20.00
8. Spectrophotometer. Cambridge Instr. Co. £15.0.0
9. Episkotister. Krille. Mk. 25.00
10. *Episkotister. Krille.[1] Mk. 15.00

III. Visual Sensation: Quality.

11. 3 electrical color-mixers. Zimmermann. each Mk. 30.00
12. 3 electrical color-mixers. Made in Ithaca. Porter motor. each $1.50
13. 3 clock-work color-mixers. Krille, new model. each Mk. 75.00
14. Electrical color-mixer, adjustable during rotation. Marbe. Zimmermann. Mk. 240.00
15. Indirect vision color-mixer. Hering. Rothe. Mk. 147.00
16. Mechanical demonstration color-mixer. Wundt. Krille. Mk. 140.00
17. Electrical demonstration color-mixer. Elbridge El. Co. $30.00
18. Color-mixer. Lambert. Made in Ithaca. $3.00
19. Pseudoptics. Münsterberg. Bradley. $5.00
20. 24 doz. color discs. Hering. Rothe.
    (1) 11 cm. diam., per doz. pf. 30 to 65
    (2) 20 cm. diam., per doz. pf. 80 to Mk. 1.90
21. 12 doz. color-discs. Wundt. Zimmermann. 2 sizes. Mk. 17.25
22. 12 demonstration color-discs, 60 cm. diam. Wundt. Krille. Mk. 35.00
23. Full set colored and gray papers. Bradley.
24. 100 discs, illustrating 'spectrum top.' Ives, and made in Ithaca. ca. $15.00
25. 2 doz. skeleton discs, for gelatines. Zimmermann. ca. Mk. 5.00
26. 3 sets gelatine sheets. Kirschmann. Krille, Zimmermann. ca. Mk. 12.00
27. 12 pupils' color-tops. Bradley. $ .50
28. Double-axle mechanical color-mixer. Zimmermann. Mk. 65.00
29. Spectrum chart. Framed. Prang. $1.00
30. Chart of pure spectrum scales. Framed. Bradley. $ .50
31. Standard of color. Prang. $ .50
32. Iceland spar. Ziegler. $ .50
33. Full set gray papers. Hering. Rothe.

IV. Visual Sensation: Contrast, Color-blindness, etc.

34. Demonstration after-image apparatus. Wundt. Krille. Mk. 60.00
35. Stroboscope, with 12 photographic strips. Anschütz. Kohl. ca. Mk. 21.00
36. Artificial waterfall. Bowditch. Made in Ithaca. $4.00
37. 6 double stroboscopic discs. Stampfer. Trentsensky. Fl. 3.00
38. Wall-campimeter. Ca. 4 x 2 m. Black and white surfaces. Made in Ithaca. $10.00
39. Perimeter. Badal. Queen. $17.50

[1] The asterisk denotes that the instrument is not the property of the laboratory.

40. 5 gray screens to III. 15, *q. v.*
41. Demonstration contrast cards. Made in Ithaca.
42. 6 contrast discs. Helmholtz. Made in Ithaca.
43. 500 colored paper-rings. Hailmann. Bradley. $ .40
44. Screens and discs for quantitative determination of brightness contrast. Made in Ithaca.
45. Test-worsteds for color-blindness. Galton. Cambridge Instr. Co. £3.10.0
46. 100 worsteds. Holmgren. Queen. $6.00
47. Instrument for testing color-blindness. Hering. Rothe. Mk. 100.00
48. Binocular color mixer. Hering. Rothe. Mk. 32.00
49. Simultaneous contrast apparatus. Hering. Rothe. Mk. 40.00
50. Mirror contrast apparatus. Hering. Rothe. Mk. 28.00
51. Binocular shading apparatus. Hering. Rothe. Mk. 35.00

V. Visual Perception.

52. Apparatus for testing relative legibility of words and letters. Made in Ithaca. $10.00
53. Printed words and letters for use with above. Wood. $2.00
54. Screen for demonstration of Listing's law of eye-movement. Ca. 2.25 x 3 m. Made in Ithaca. $15.00
55. Instrument for estimation of angles. Galton. Cambridge Instr. Co. £2.0.0
56. Eye-measurement screen. Münsterberg. Elbs. $22.00
57. Eye-measurement screen. Made in Ithaca. $8.00
58. Cards for optical illusion. Knox & Watanabe.
59. 6 wire-models, showing Müller-Lyer illusion.
60. Wheatstone stereoscope and telestereoscope. Sanford model. Whitney. $10.00
61. Troposteroscope. Ludwig. Petzold. Mk. 34.00
62. Album des centres nerveux. Debierre and Doumer. Alcan. Fr. 20.00
63. Mirror pseudoscope. Stratton. Made in Ithaca. $3.00
64. Pseudoscope. Michigan App. Co. $12.00
65. Perspectoscope. Perspecto Mfg. Co. $2.00
66. Hand stereoscope. (Perfecscope). Underwood. $1.50
67. Hand stereoscope (stereoscope model). Petzold. Mk. 8.50
68. 36 stereoscopic slides, with explanatory text. Martius-Matzdorff. Eckenrath. Mk. 6.00
69. 12 stereoscopic slides, illustrating lustre. Martius-Matzdorff. Eckenrath. Mk. 3.50
70. 18 selected stereoscopic slides. Jarvis, etc.
71. 8 stereoscopic lunar photographs. De la Rue. Petzold. Mk. 3.00
72. 10 selected stereoscopic slides for study of distance in inverted landscape. Braun, etc.
73. 24 diagrammatic slides, after Wundt and Hering. Made in Ithaca.
74. Celluloid slides, for free stereoscopy. Made in Ithaca.
75. Monocular fall-apparatus. Hering. Made in Ithaca. $2.50
76. Horopter model. Ludwig. Petzold. Mk. 150.00
77. Apparatus for demonstration of Listing's law of eye-movement. Ludwig. Petzold. Mk. 30.00
78. Large horopter model. Sanford, after Hering. Clark Lab. $15.00
79. Model of field of regard. Sanford, after Helmholtz. Whitney. $30.00
80. Apparatus for perception of forms liminally different

from their background. After Leuba. Made in Ithaca. $5.00

81. Apparatus for mapping retinal circulation by entoptic vision. Made in Ithaca. $5.00

82. 30 sets blind-spot cards. Scripture. Willyoung. each $ .15

VI. Visual Association, Memory, etc.

83. Material for study of mediate association. Howe. Collected in Ithaca.

84. Material for study of problems in individual psychology. Sharp. Collected in Ithaca.

85. Drop-apparatus, exposing series of letters, etc. Jastrow. Garden City Model Wks. $12.00

86. Dark chamber, table, asbestos lantern-cover, screens, reflectors, head-rest, etc., for study of association. Partly after Scripture. Made in Ithaca.

87. 30 selected lantern-slides, plain and colored, for study of association, memory, etc. Colt, etc. $20.00

88. 20 wood models for study of memory of visual form. Made in Ithaca.

89. 3 small tanks for colored liquids (color memory). Made in Ithaca. each $1.00

VII. General Optical Apparatus and Materials.

90. Spectroscope. Société génévoise. Fr. 300 00

91. Reading telescope. Cambridge Instr. Co. £5.0.0

92. Lens of crown glass, on elevating brass stand, 5 in. diam. Queen. $11.00

93. Equilateral prism, on elevating brass stand, 5 in. length. Queen. $11.00

94. Glass prism, equilateral, with cut handles, 6 in. Ziegler. $ .60

95. Porte-lumière. Ritchie. $5.00

96. *Photographic lens. $5.00

97. Triple diaphragm, with mm. scales. Kirschmann. Krille. Mk. 45.00

98. 2 plane mirrors, ca. 40 x 25 cm. each $2.00

99. 2 sets of colored glass plates. Krille. Mk. 15.00

100. Black tubes, metal and card, with diaphragms. $5.00

101. Large cloth screens, 2 black, 2 white. $8.00

102. Photographic camera. $30.00

103. Magnesium lamp, with reflector and tape. Eimer and Amend. $3.00

104. Photographic time and instantaneous pneumatic shutter. Queen. $6.50

105. 2-in. diam., 8-in. focus, biconcave and biconvex lenses. Ritchie. $2.50

106. *12 lantern slides in case.

107. 6 small and 2 large Geissler tubes. Ziegler. $6.50

108. Dark box for above. Made in Ithaca. $1.00

109. Dark box. Sanford. Made in Ithaca. $4.00

110. Projection lantern, with oil-burner, 2 Welsbach gas burners, 2 arc lamps. Eimer and Amend, etc. $18.00

111. Criterion projection lantern, with automatic arc lamp. Colt. $112.00

112. Adjustable stand for above. Gennert, modified. $20.00

113. Ground glass screen, ca. 1 x 1.5m., with adjustable shutters, for lantern-slide projection. $18.00
114. Dark chamber, sink, ruby window, chemicals, for developing photographs.
115. Convex-concave mirror. Ziegler. $2.25
116. *Histological-mineralogical miscroscope, with accessories. Leitz. ca. Mk. 800.00
117. *Microscope lamp. Eimer and Amend. $6.00
118. *Collection of 400 microscope slides of brain, sense-organs, etc.
119. Set of drawing instruments, 2 dotting pens, drawing inks, colored crayons, charcoal points, black and white cardboard, protractors, 12 pairs dividers, limb extensions, celluloid squares and curves, 12 paper mm. scales, 15 wooden mm. scales, architects' paper, drawing blocks, cross-ruled paper, colored spectacles, ground and milk glass, etc.

C. Haptics and Organic Sensation.

I. Haptical, etc., Sensations: Intensity.

1. Pressure balance. Scripture. Willyoung. $8.00
2. Minimal weights. Scripture. Willyoung. $3.00
3. 9 weights for method of right and wrong cases. Jastrow. Garden City Model Works. $8.50
4. 16 weights. Scripture. Willyoung. $4.00
5. 30 Weights. Galton. Cambridge Instr. Co. £5.0.0
6. 2 glass funnels, with weights of shot.
7. 6 wooden cylinders for loading with shot. each $ .25
8. Wooden egg for loading with shot. $1.00
9. Set of 100 cartridge weights. Sanford. Made in Ithaca. $2.50
10. Set of 120 envelope weights. Sanford. Made in Ithaca. $1.00
11. Pressure balance. Von Frey. Zimmermann. Mk. 40.00
12. Algesimeter. Cattell. Brown. $15.00

II. Haptical, etc., Sensations: Quality.

13. 4 pressure pencils. Scripture. Willyoung. each $1.35
14. 8 pressure pencils. Made in Ithaca. each $ .05
15. Apparatus for exploring cutaneous surface. Washburn. Krille. Mk. 50.00
16. 2 atomizers for inducing anæsthesia. each $1.00
17. Menthol pencil. $ .10
18. Improved kinesimeter, with attachments and armrest. Hall. Yale Lab. $100.00
19. 4 temperature tubes. Scripture. Willyoung. each $2.00
20. 12 temperature cylinders. Goldscheider. Made in Ithaca. $3.00
21. 1-gal. copper vessel, fitted with two Roux regulators and 3 Friedrich burners.
22. 2 thermometers, graduated in degrees,—24 to+200° *C.* Eimer & Amend. each $1.75
23. Thermometer, graduated in degrees,—25 to+250° *C.* Eimer & Amend. $2.00
24. Thermometer, graduated in tenths of degrees,—7 to+100° *C.* Eimer & Amend. $4.00
25. Thermometer, graduated in degrees,—10 to+250° *C.* Eimer & Amend. $1.75

26. Upright physiological inductorium. Du Bois-Reymond. Petzold. Mk. 120.00
27. 1 bipolar electrode; 1 unipolar electrode; 1 plate electrode. Chloride of Silver Dry-plate Battery Co. $5.00

III. Haptical, etc., Perception.

28. Apparatus for perception of movement by the elbow. Sanford. Willyoung. $8.00
29. Set of blocks and points for filled and open space. Titchener. Krille. Mk. 10.00
30. 23 rubber strips for estimation of extent by the skin. Titchener. Made in Ithaca. $ .50
31. Interrupted-extent apparatus. Titchener. Willyoung. $20.00
32. Set of glass and rubber forms for determination of cutaneous form-limina. Major. Eimer & Amend. $5.00
33. 12 surfaces for cutaneous impression. Made in Ithaca. $1.00
34. Set of charcoal points, with sharpener, for localization experiments. $1.00
35. 4 rods, 5 handles, 2 cups, etc., for study of eccentric projection. $5.00
36. Stationary apparatus for study of eccentric projection. Made in Ithaca. $5.00
37. Rectilineal arm-movement apparatus. Münsterberg. Elbs. $45.00
38. Combined tilt-board and rotation-table. Titchener. Willyoung. $50.00
39. Set of 7 needle-æsthesiometers. Washburn.
40. 4 simple æsthesiometers. Scripture. Willyoung. each $2.00
41. Dynamometrical æsthesiometer. Griesbach. Brändli. $17.00
42. 2 bristle æsthesiometers. Von Frey. Zimmermann. each Mk. 45.00
43. 2 slide æsthesiometers. Washburn. Brown & Sharpe. each ca. $20.00
44. 2 pain æsthesiometers. each $1.00
45. Materials for study of perception of liquidity. $5.00
46. 5 frames for 'facial vision.' Made in Ithaca. $2.50
47. Steadiness gauge. Scripture. Willyoung. $6.00

IV. Anatomy and Physiology of Organ of Static Sense.

48. Dissection of semi-circular canals of pike.
See also A, I, 1, 2.

V. Charts, etc.

49. Plate of haptical instruments. From Amer. Journ. of Psychol. VI, 3, VII, 1. Framed.
50. Chart showing localization of cutaneous impressions. From Amer. Journ. of Psychol., VII, 1. Framed.
See also H, IV.

D. Taste and Smell.

1. Double olfactometer. Scripture. Willyoung. $3.00
2. 2 clinical olfactometers. Zwaardemaker. Harting Bank. each Fl. 4.00
3. Double clinical olfactometer. Petzold. Mk. 16.00
4. Standard double fluid-mantle olfactometer. Zwaardemaker. Harting Bank. Fl. 42.00

5. Metal mirror, 3 bell jars, glass alcohol-lamp, set of duplicate glass tubes, etc., for olfactometric work. $15.00
6. 18 olfactory cylinders for clinical olfactometer. Gamble. Made in Ithaca. ca. $10.00
7. 13 standard solutions for fluid-mantle olfactometer. Gamble. Made in Ithaca. ca. $10.00
8. Set of 24 fruit flavors for taste experiments. Royce. $4.00
9. Set of 30 solutions for taste experiments. Made in Ithaca. ca. $5.00
10. Set of 29 samples of essential oils, etc., for olfactory work. Fritzsche.
11. Set of 80 solutions for olfactory work. Made in Ithaca. ca. $5.00
12. Barometer. Ziegler. $8.00
13. Set of solutions for mixed tastes and false tastes (burning, pricking, etc.). Made in Ithaca. $3.00
14. Enlarging mirror. See Vision VII, 115.
15. Camel's-hair brushes, small and large phials, burettes (Bausch & Lomb), pipettes (Eimer & Amend), rubber corks, caraffe and glasses, earthenware vessels, hard rubber syringes, etc., etc. ca. $25.00
16. Enlarged photograph of tip of tongue, showing papillæ. Oehrwall. Framed. $1.00
17. Preparation of tongue of calf, showing papillæ.

E. Affective Processes.

I. Special Instruments.

1. Combined spring and weight ergograph. Cattell. Horstmann. $35.00
2. Weight ergograph. Mosso. Willyoung. $45.00
3. Tridimensional movement analyzer. Sommer. Schmidt. Mk. 85.00
4. Sphygmograph, with complete set of attachments and arm-rest. Von Frey. Zimmermann. Mk. 200.00
5. Laryngograph. Verdin. Fr. 60.00
6. Pneumograph. Verdin. Fr. 50.00
7. Pneumograph. Sumner. $2.50
8. Dynamograph. Verdin. Fr. 130.00
9. Hand Dynamometer. Collin. Zimmermann. Mk. 27.50
10. Automatograph. Made in Ithaca. $2.00
11. Plethysmograph. Lombard. Michigan App. Co. $16.00
12. Sphygmomanometer. Mosso. Verdin. Fr. 190.00
13. Plethysmograph. Franck. Verdin. Fr. 30.00
14. 2 spring balances (for dynamometry). Chatillon. Ziegler. each $1.25

II. Models, etc.

15. Model of course of emotion. Wundt. Made in Ithaca. $2.00
16. 4 masks illustrating expression of emotion. Hennecke. $5.25
17. 8 photographs illustrating expression of emotion. Framed. Soule. $1.60
18. Bust of Femme inconnue. Donatello. Caproni. $6.00

III. General (Recording) Instruments and Materials.

19. Recording chronometer. Jacquet. Verdin. Fr. 170.00

20. Large endless-paper kymograph for 9-in. paper. Francis. $120.00
21. Endless-paper kymograph, with 2 drums, clock-work movement: all accessories. Ludwig. Petzold. Mk. 900.00
22. Simple kymograph, weight attachment. Petzold. Mk. 85.00
23. Small clock-work kymograph. Zimmermann. Mk. 185.00
24. Double set of tambours. Marey. Krille. each Mk. 40.00
25. 30 writing-points (metal, glass, bamboo). Zimmermann. Mk. 13.00
26. Set of glass, metal and porcelain T-ways and Y-tubes for rubber tubing.
27. Rubber tubing, various sizes.
28. Deprez time-marker. Zimmermann. Mk. 75.00
29. Simple time-marker. Petzold. Mk. 28.00
30. Simple time-marker. Krille. Mk. 9.00
31. Clock-work chronograph, with tuning-fork and hammer controls. Wundt. Zimmermann. Mk. 1,180.00
32. Glazed paper for kymographs and chronograph.
33. Varnishing tray, etc., for smoked records. Made in Ithaca. $5.00
34. Adjustable stand for revolving drums for smoking. Von Frey. Zimmermann. Mk. 50.00
35. Triple fan-flame gas-burner for smoking drums. Chicago Laboratory Supply Co. $ .85

F. Action.

I. Special Instruments.

1. 7 vernier chronoscopes with attachments. Sanford. Whitney. $35.00
2. 2 Hipp chronoscopes, new pattern. Krille. each Mk. 280.00
3. Large control hammer. Wundt. Krille. Mk. 290.00
4. Voice-key with relay. Cattell. Krille. Mk. 102.00
5. Lip-key. Cattell. Krille. Mk. 22.50
6. Finger-key. Dessoir. Yale Lab. [Zimmermann. Mk. 32.00]
7. Five finger key. Jastrow. Garden City Model Works. $7.50
8. Fall apparatus. Appunn. Krille. Mk. 135.00
9. 2 electro-magnetic sound hammers. Wundt. Krille. each Mk. 47.50
10. Large pyramidal pendulum for light stimuli. Krille. [Improved form, Zimmermann. Mk. 480.00]
11. Stimulator, with set of rubber forms, for cutaneous reactions. Titchener. Whitney. $7.50
12. 7 simple reaction-keys. Krille. Zimmermann. each Mk. 10.00-Mk. 35.00
13. Electric-pneumatic reaction-key. Zimmermann. Mk. 35.00
14. Electric-pneumatic pen. Henry. Zimmermann. Mk. 24.00

II. General Instruments and Materials.

15. 10 commutating keys. Zimmermann. each Mk. 15.00-Mk. 30.00
16. 2 German-silver wire rheochords. Krille. each Mk. 20.00
17. Wire, various sizes.
18. 3 wall-diagrams, with text, illustrating Hipp chronoscope. Framed. Made in Ithaca.

See also Affective Processes, III. General Supplies.

G. Attention.

1. Demonstration fall-chronometer. Wundt. Krille. Mk. 48.00
2. Complication apparatus. Wundt. Krille. Mk. 175.00
3. Set of discs for fluctuations of attention. Made in Ithaca.
4. Set of photographic word-slides, for apperception. Pillsbury. Made in Ithaca.
5. Exposure apparatus. Jastrow. Garden City Model Works, $8.50

See also A, IV; B, V, VI; C, III; D; E, I, III; F, I.

H. General Supplies.

I. Electrical Outfit.

1. Simple galvanometer. Queen. $5.00
2. Telephone, with attachments. Ziegler. $18.00
3. 7 electric bells, with push-buttons.
4. Cherry voltmeter and ammeter. each $1.50
5. Current tester. Krille. Mk. 4.50
6. 24 incandescent lamps, various sizes, with receptacles, switches, etc., for resistance.
7. 7 Daniell cells. $14.00
8. 12 Leclanché cells. $12.00
9. 3 Meidinger gravity cells. Mk. 19.50
10. 3 Edison-Lalande cells. $9.75
11. 24 Fleischl cells, in cases. Mk. 100.00
12. 2 chloride accumulators. $28.00
13. 20 lbs. quicksilver. $15.00
14. Large tinned-iron rheostat. Nichols. Made in Ithaca. $3.50
15. 2-in. spark induction coil. Ziegler. $34.10
16. Sliding brass wire rheostat. Horstmann. $5.00
17. 12 doz. connectors. $12.00
18. 12 doz. binding posts. $12.00
19. Five-point switch. Queen. $ .75
20. 30-fold system of wires, connecting rooms.
21. Direct current, 110 volts, in 7 rooms; switches and glass-doored switch cases. (Day current).
22. Illuminating system, alternating current, 110 volts, in all rooms. (Night current.)
23. Crocker-Wheeler motor, ⅛ H. P., 1600 r. p. m., 115 v. $22.50
24. Speed reducer. Pillsbury. Michigan App. Co. $12.00
25. Combined dynamo and motor model. Elbridge El. Co. See Vision, III, 17.

II. Mechanical and Chemical Outfit.

26. 14 standards; 11 arms; 18 clamps; 4 rubber clamps; 12 pulleys. Eimer & Amend, White, Petzold, etc. $45.00
27. 4 oil lamps.
28. 2 Bunsen burners. each $ .50
29. 4 Friedrich burners.
30. Glass-ware, various.
31. Full set carpenter's tools.
32. Gas in 5 rooms.
33. Water in 3 rooms.
34. 3 adjustable chairs. each $5.00
35. Couch. $15.00

36. 8 instrument cases; 2 chart cases; 2 battery and store cupboards.
37. Water motor. Zimmermann. Mk. 12.50
38. 2 gals. each sulphuric and nitric acid; 1 gal. each turpentine, hydrochloric acid, odorless paraffin, absolute alcohol.
39. Ether; shellac and alcohol varnish; machine oil; lamp-black; rubber cement, etc., etc.
40. Quarter-second stop-watch. $6.00
41. Fifth-second stop-watch. $6.00
42. Fifth-second stop-watch. $6.50
43. Chemical balance with weights. Eimer & Amend. $49.00
44. Cotton wool; cloth; wood for models, etc.; wood and card boxes; twine, silk; glue, paste, mucilage; oakum, waste; spare gas-pipes; leather, various sorts; wax, various sorts; cardboard instrument covers, all sizes; etc., etc.

III. Physiological and Anatomical Outfit.

45. *Case of physiological instruments.
46. Case of physiological instruments.
47. Odd physiological instruments (scissors, scalpels, etc.)
48. Large elastic model of brain, Auzoux. Fr. 300.00
49. Set of 10 brain models. Steger. Mk. 64.00
50. *Articulated skull, with restoration of ear.
51. *Series of 12 brains.
52. 12 wall diagrams (colored) of brain and sense-organs. From Wenzel, Anatomischer Handatlas. Stauffer. Framed. Mk. 16.00
53. *Epitome of cranial nerves. Rider, after Heiberg. Framed.

IV. Diagrams, etc.

54. 3 large photographs of first psychological laboratory of Cornell University. Framed.
55. Chart to illustrate metric system. Amer. Metrol. Soc. Framed.
56. Set of 50 wall-diagrams to illustrate Course in Systematic Psychology.
57. Series of 35 psychological portraits. Open Court Pub. Co. Framed. $7.75
58. Large platinotypes of Wundt and Fechner. Bellach. Framed. each Mk. 60.00
59. Etched portrait of Chas. Darwin. Hollyer. Keppel. Framed. $1.00
60. *40 frames of psychological portraits, autographs, etc.
61. Bust of Aristotle. Hennecke. $7.50
62. Portraits of Helmholtz and Donders from Arch. f. Ophthalmologie. Framed. $2.00

Various instruments, now on order or in the making, have been omitted from the above list. Nothing is said, in particular, of the series of simple pieces which is in course of construction for the writer by the Chicago Laboratory Supply Co. A special circular, describing these pieces, will shortly be issued by the firm.

PSYCHOLOGICAL LITERATURE.

Zur Analyse der Unterschiedsempfindlichkeit. Experimentelle Beiträge von LILLIE J. MARTIN und G. E. MUELLER. Leipzig, J. A. Barth, 1899, pp. vi, 233.

Probably all psychologists who are accustomed to reflect seriously on what they have experienced in judging small differences of stimuli, have felt that the usual rules laid down in the psychophysical methods for the elimination of constant errors, were treating in a very abstract and mechanical manner extremely complicated and more or less erratic processes. That like stimuli should seem to vary quantitatively and qualitatively from day to day, that periods of ease and of difficulty in comparing stimuli should follow one another intermittently, that now one order of standard and variable should be easier to 'judge' and later on the reverse order, are matters which, psychologists are beginning to feel, are not to be put aside with a reference to 'probable indisposition of reagent' or to 'some disturbances in the course of experimentation,' but are themselves subjects for investigation. That is, there are signs that psychologists are coming to feel their next concern is not with further determinations of sensitiveness to difference and with the mathematical elaborations of the psychophysical methods based on the laws of large numbers, but with the complicated psychical processes underlying the method, and a very solid and valuable expression of this feeling is to be found in this *Analyse* of Martin and Müller.

The method of right and wrong cases, or, as the authors prefer to call it of "constant differences" is the peg on which the investigation is hung; but, as stated in the preface, the object was not the massing of results for determining some "so-called sensitiveness to difference," but the analysis of the physiological and psychological factors by means of which the results themselves were determined.

Suppose in an investigation for determining sensitiveness to difference for 'hefted' weights with the usual reversal of time and space order which is supposed to eliminate time and space errors, the investigator having collected his results, should run against a summary like this :—

SUMMARY OF JUDGMENTS (p. 101).

Order I.	Standard-Variable:	lighter	203	times:	like	479	times:	heavier 214 times:
Order II.	Variable-Standard:	"	106	"	"	561	"	" 229 "

According to orthodox views of error elimination, if there is practical equality of "lighter" and "heavier" in Order I, there should be in Order II; or, if there are more "lighter" judgments in I than in II, there ought to be correspondingly more "heavier" judgments in II: but the "heavier" in I about balance those in II.

When the aim of the investigator has been to determine sensitiveness to difference he has not usually thought it necessary to discuss this condition of results, but has passed rapidly on to the consideration of the relative numbers of right, wrong and doubtful cases, to determinations of sensitiveness and thence to 'laws.' The investigation of such anomalous conditions as appear in the above summary is the main object of the present research, and the results must directly affect the validity of the method of right and wrong cases so far as it

rests on experiments with 'hefted' weights, and indirectly its validity with other kinds of stimuli. The working conditions were essentially those of Müller's earlier work with Schumann.[1] One hand was used and the judgment was referred to the second weight. The standard weight ranged from 416 to 3,221 grams. and for each standard there were usually 7 variables,—three above, three below and one like the standard. The height of lifting was limited by a taut horizontal string, and the time was determined by a metronome. The authors chose this method in preference to Wreschner's physiologically simpler arrangement, partly because they wanted to follow out Müller and Schumann's line of work, and partly because they preferred to experiment on a 'natural' every-day movement. The reagents were directed to deliver their judgments under the heads of 'larger clearly,' 'larger' 'undecided' 'smaller' and 'smaller clearly.' The discussion of the various forms of judgments tried and the reasons for adopting the above categories would form good prolegomena to some future handbook on psychophysical methods of measurement. The attitude of the reagent towards 'larger clearly' *e. g.*, was quite different from that towards 'clearly larger.' 'Undecided' comprehended all cases when reagents did not feel sure of a 'larger' or 'smaller,' together with the comparatively few cases of a positive conviction of 'like.'

The deviations from a symmetrical grouping of results as shown, *e. g.*, in the above 'summary of judgments,' are due to factors in the process of comparing which are analyzed under the heading of "Anomalous differences in the numbers representing right judgments." The first of these "anomalous differences" is shown in the fact that more right judgments are given when the variable comes second than when it comes first (Order I); this holds good whether the variable is greater or less than the standard. The influence producing this effect is termed the general tendency of judgment; it is present in all reagents, and comes from the prevalence of *absolute* impressions of heaviness or lightness,—*i. e.*, impressions in which no comparison with another definite weight takes place any more than when in lifting a book or letter we call it heavy or light. The heavier the variable the more active the tendency. The evidence for the existence of such absolute impressions comes, of course, from the reagents who in many cases were not aware of a trace of a comparison with the standard weight. One reagent remarked: "If I decide that a weight is clearly greater or smaller than another, the judgment does not rest on a difference in the weights, but chiefly on the fact that the weight appears to me in a general way very large or very small." (p. 45.) Under these conditions one might expect a tendency in case of the order variable-standard to call the variable lighter or heavier before the standard was touched; this was the case with some reagents, and the tendency rather increased than diminished with practice. With many reagents it was found that the judgments were given with the maximum feeling of ease and security when the variable followed the standard. These and similar statements the authors hold are only to be explained on the theory of 'absolute impressions.'

Another irregularity noticed in the distribution of right cases is termed the anomaly of type. Some reagents gave more right judgments when standard > variable, and others when standard < variable. The first class was of the positive type:—it was made up of five men and one woman—that is of comparatively muscular individuals, the one woman being well exercised in household work. The second class was made up of five women and one man, that is of comparatively

[1] Müller und Schumann: Ueb. d. psycholog. Grundlagen d. Vergleichung gehob. Gewichte. *Pflüger's Arch.*, XLV, 37.

weak individuals, the one man having a slight muscular development. These conditions, along with the tendency to judge from absolute impressions, readily explain the anomalies of type. The strong or positive type, *e. g.*, would more easily get an absolute impression of "less" than of "greater," consequently would give more correct judgments when standard > variable. Obviously the influence of a type will work with the general tendency of judgment in one part of each order of standard and variable and against it in the other part.

The clear cases noted above under the headings of "larger clearly" or "smaller clearly" are obviously those in which the effects of absolute impressions should be most prominent, for in such cases there would be the least disturbance of conviction by comparison. In 'clear cases,' therefore, the type should stand out more conspicuously than in the total judgments. As a matter of fact the type can usually be determined by reference to the 'clear cases' when it is hidden in the total summaries. On page 231 the authors express the opinion that such absolute impressions probably take place with other kinds of sensations, in which case the accuracy of judgment must be fairly independent of the time-interval between standard and variable. In some experiments with clangs, carried out a few years ago,[1] to get some insight, if possible, into the nature of the so-called memory-image, which plays so heavy a part in the explanation of memory experiments, the writer found that for time-intervals from 1 sec. up to 60 sec. there was but little falling off in accuracy of judgment with increase in time for differences of stimuli (8 and 4 vibrations). Finding, moreover, that judgments were delivered with more ease and a feeling of security for time-intervals filled with absorbing distraction, and that the distraction did not strongly or regularly affect the number of correct judgments, the experimenters came to the conclusion that for the most part no comparison of standard and variable took place; *i. e.*, that the judgments were based on 'absolute impressions' as Martin and Müller term them.

As the direction of general judgment and type tendencies depend on the time order of the stimuli, they may be considered as parts of the general or resultant time error, though unlike the ordinary or Fechnerian time error they are not eliminable. The authors find in their results, however, an error which amounts to a positive or negative addition to the difference between standard and variable, according to their time order. They call this the Fechnerian time error, and attribute it to physiological causes — either fatigue or excitation, according to the strength and disposition of the reagent. According to its sign this time error may act with or against the general tendency of judgment, and with or against the type. The physiological nature of the error is evidenced by the fact that while the positive type may show either kind of Fechnerian time error, positive or negative, the negative type shows only the negative error.

These three factors — the general tendency of judgment, the type, and the Fechnerian time error together — will explain the contradictory figures given above, *i. e.*:

Standard = 440 grams; Variables = 470, 460, 450, 440, 430, 420, 410 grams.

	Lighter.	Indiff.	Heavier.
Time Order I.....	203	479	214
Time Order II.....	106	561	229

If the 'clear' cases should be separated out from these judgments, the

[1] *Vide*, Angell and Harwood: Experiments on Determination of Clangs, etc., *Am. Jour. Psychology*, XI, 1899, 67 ff.

positive type would appear, *i. e.*, more right cases would be found in these clear judgments when standard > variable than under the reverse condition. Distributing to each of the seven values of the variable the actual number of judgments falling on that variable, classified according to the judgment categories of "heavier clearly," "heavier," etc., one gets a table showing the direction of the Fechnerian time error. For instance, with standard and variable alike (Difference D = 0) more judments of 'larger' fell on the variable in Time Order I, and more on the standard in Time Order II. *i. e.*, the Fechnerian time error is "negative."

Accordingly, in the above summary the type and Fechnerian time error are opposed in Time Order I, so that the "lighter" and "heavier" judgments almost balance, the slight excess of "heavier" (203 : 214) indicating possibly that the Fechnerian time error tendency is slightly stronger than the type. The general judgment tendency is, of course distributed equally over both "lighter" and "heavier." In Time Order II the influence of type and time error is in the same sense, *i. e.*, towards judgments of "heavier;" and the result is a very great falling off in 'lighter' judgments.

In analyzing out these several tendencies the authors used two kinds of tables: a series of "Summaries of Judgments" similar to that given above, and another of the distribution of right cases under the several categories of judgment for each value of D (difference of standard and variable). Each kind of table brought out tendencies hidden in the other, and, what is especially valuable in so great a complication of factors, each serving, in a measure, as a check on the other.

The effect of practice also turned out to be very different from what might be anticipated. So far from the results becoming more regular with practice, they sometimes changed character entirely — a negative type becoming positive, and *vice versa*. It was shown later that a reagent's measure of conviction for delivering a certain kind of judgment did not remain the same. In general, the authors assert (p. 134) that the effects of practice are harder to determine than any other subsidiary tendency.

What part is played in these judgments by an actual comparison of standard and variable? The answer to this question is somewhat surprising. "We are by no means of the opinion," the authors say (note, p. 49), "that a comparison of weights never takes place. Those comparisons, however, which are the easiest to determine, are, strange to say, not comparisons between the standard and its variables, but a comparison between a variable which has just been 'hefted' and the variable of the immediately preceding experiment." For example, one of the reagents said: "Just as I was about to say 'greater clearly' I remembered that the preceding judgment was based on a sensation which was greater than the one just experienced, and so for the latter I merely said 'greater,'" (p. 155).

The tendency expressed in notes of this kind was investigated by means of control experiments (*Vexir-Versuche*). In a series of eight variables, *e. g.*, three were like the standard, the remaining five forming an arithmetical series, all larger, or all smaller than the standard, as the case might be. The object of the arrangement was to determine the effect of preceding impressions of "heavier" or "lighter" on the central experiments. The effect of a preceding difference producing say the correct judgment 'smaller,' was to produce a tendency towards 'larger' judgments when the standard was equal to the variable, and in general this tendency was the more marked the greater the preceding difference. For example, with a standard of 485 grams, the preceding variable 460 produced 18 'greater' judgments in the central

experiments, whilst 410 as preceding variable produced 35 "greater." As was to be expected from the above results a similar influence affected the general experiments; analysis of the data shows that judgment of the smaller values of D was influenced by preceding greater values of D.

In this case of 'indirect comparison' the comparison takes place between single perceptions; another form of 'indirect comparison' which may disturb the first is due rather to a comparison of differences, and this results in a change of criterion for any given form of judgment; if, for example, the actual differences between standard and variable are very large the reagents will, so to speak, become accustomed to a stricter criterion in applying the judgments "larger" and "smaller," so that their judgments will be given only through some very clear impression of greater or smaller. The result will be that the mistakes of judging the control experiments as 'larger' or 'smaller' will rarely be made. (p. 171.) A confirmation of this is found in Kämpfe's investigation, (*Phil. Stud.*, VIII, S. 549) in which control experiments were used. The greater the actual difference between standard and variable the less the errors of judgment in the control experiments; and the less the value of D the greater the number of errors for the cases when D = 0.

Excluding errors of space order there are then, according to this analysis, no less than five possible influences at work in determining judgments on 'hefted' weights when all outer and inner conditions are made as constant as possible.

1° The general tendency of judgment, resulting in more correct judgments when the variable follows the standard.

2° Influence of the type—positive and negative.

3° Influence of the Fechnerian time error—positive and negative.

4. Influence of size of variable in preceding judgment.

5. Influence of change of criterion for delivering judgments. Of all these the only one that is theoretically eliminable is the Fechnerian time error.

A complete investigation of space errors was not contemplated by the authors. Experiments involving space errors were, however, carried out with reference to the type tendencies. It was found that either position (right or left) might be positive or negative in the Fechnerian sense.

Other interesting points developed by the experimentation were the compensation effects, on the judgments, of reference to the first or second weight, the influences of partial knowledge of the conditions of experimentation, and of the conditions affecting the time of delivering a judgment. As a whole the work contains material enough for half a dozen ordinary *Arbeits*.

But despite the many factors analyzed out by the authors one rarely feels he is on shaky ground, partly because the results agree when looked at from different standpoints, and partly because the conclusions fit in with common sense views, as in the case of the unusually strong and weak types, or with tendencies which any observant psychologist has noticed in his own experience, as is the case with the absolute impressions and indirect comparisons.

In the preface, Prof. Müller states that a main purpose of the work is by means of criticism to contribute something towards dispelling the illusion that the complicated and difficult province of psychology is peculiarly that in which one can further scientific knowledge with a minimum outfit of acquirements and training. It is probably no injustice to Prof. Martin, who, as the preface states, really conducted the work, to surmise that the drastic criticism of Wreschner's

"*Methodologische Beiträge*," as well as the discussion of Cattell and Fullerton's "Small Differences of Sensation," proceed from the pen of Prof. Müller. Into these criticisms, as well as into a discussion of the support which this *Analyse* gives to Müller and Schumann's theory of 'hefted' weights, this is hardly the place to enter, as the object of this paper is to give, if possible, an intelligible résumé of a work which is as uncommonly hard to read as it is uncommonly rich in acute and sound psychological analysis.

F. ANGELL.

SOME RECENT ITALIAN PSYCHOLOGICAL LITERATURE.

By ALEXANDER F. CHAMBERLAIN.

In these brief abstracts and review-notes of recent Italian psychological literature no attempt has been made to cover the entire field, or to go into details of facts and technicalities, but simply to give in a few words some of the more important points discussed, theories advanced, suggestions made, and contributions of value added to the literature of the subjects treated. The topics considered are such as have appealed specially to the present writer.

Riddles. Dr. V. Giuffrida-Ruggeri[1] has found the "riddle," that test play of the folk, worthy a psychological study,—the foundations for such an investigation were laid long ago in the encyclopædic collections of Pitré, the *doyen* of Italian folklorists. It is in the riddle that is "poetically hidden" the wisdom of the folk-soul. The author attempts a classification of riddles, from the psychological point of view into: Descriptive, observational, instructive, emotional, imaginative, humorous. These popular riddles are a means by which we can get at "the contents of parents' minds," to a certain extent at least.

Imagination. Elsewhere[2] Dr. Giuffrida-Ruggeri discusses in rather brief fashion the "Evolution of the Imagination." Accepting the definition of Binet ("the imagination is the faculty of creating groups of images which do not correspond to any exterior reality"), he so interprets it as to exclude the traditional distinction between the "reproductive" and the "constructive" imagination, made so much of by Spencer and his disciples in psychology. It is doubtful if the so-called "reproductive imagination" is essentially different from ordinary association and memory. According to the author the evolution of the imagination is from the simply objective to the schematic, then from the schematic to the symbolic. Its course is from the primitive chaotic phantasmagoria to the symbolism that not infrequently falls a victim to involution. The history of the race and the development of the individual illustrate this evolution of the imagination. In its first stages at the beginning imagination is not very unlike the *rêverie* of a long repose. Indeed "the luxurious cycle of ancient Greek legends, a real spring-time of voluntary illusions, corresponds to what dreams are in the life of the individual, a true type of hallucinations and metamorphoses." This Greek metamorphosis is not only a transition from the known to the unknown, an extension of an anterior consciousness, but was perhaps the first classification ever

[1] Il valore psicologico dell' indovinello. Un' inchiesta sull' ideazione popolare. Riv. di Psicol., psich., e neurop., Vol. VI., pp. 1–4.

[2] L'evoluzione dell' immaginazione. Arch. per l'Antrop. e la Etnol. (Firenze,) Vol. XXVIII (1898), pp. 197–206.

made in Greece. But, although metamorphosis is the master-way of Greek imagination, there were collaterals also,—contrast, Baldwin's suggestion of contradiction, etc. The schematic reduction of a mass of legends and myths, so fruitful in the history of art represents the next stage in the folk-imagination—the banquet of Atreus, the tale of the wandering knight in the Middle Ages, are examples here. With the introduction of abstract concepts and the removal of the image, or group of images, from the sphere of the concrete, the imagination becomes symbolic.

In general, we can say concerning the evolution of the imagination: "In the great religions of classic antiquity, when the external world was reflected in the still infantile mind as in a mirror, it appears in its objective phases splendid and phantasmagorical; in the Middle Ages, when the religious feeling reached its highest paroxysm, it became schematic; lastly, when religion is in a way to become one of the many social conveniences, it turns symbolic."

The importance of the evolution of this faculty of the human mind is further emphasized by Ambrosi's[1] "Psychology of the Imagination in the History of Philosophy," a work which appeared about the same time as the article just reviewed. In his "Anthropological-Pedagogical Studies," the first volume of which appeared in 1896[2] and the second in 1898,[3] Professor Vitale Vitali discussing the resemblances and differences of a sexual sort between the school-boys and school-girls of the Romagna, devotes a section of his chapter on "Mental Constitution" to "Imagination and Association" (Vol. I, pp. 65-72; Vol. II, pp. 93-103). According to Vitali the examination of the artistic and literary productions show that women "rise through study to the comprehension of things to the reason that analyzes, that comprehends, as Legouvé says, and not to the reason that synthetizes, that creates." The drawings of the school-girls of the Romagna reveal the fact that they copy with the greatest patience and exactness; their work in general is clean, precise, but there is lacking the traits that reveal genius. Many of the boys' drawings, on the other hand, are less precise and exact, less neat and careful, but, with the few traits they possess, reveal a greater feeling for the true and the beautiful. Vitali experimented with a combination of the Dugas and Bourdon methods as to the images called up by particular words, and found that those evoked in girls were always simpler than those evoked in the boys, and always intimately associated with personality. The girls, in fact, "illustrated marvellously well the intellectual utilitarianism, that adopts the image most convenient to the ego, and not always that referring to the nature of the object recalled." Family, maternity, etc., are for them words rich in associations, the word cradle (*culla*) especially so. Out of the girls (16-20 years) interrogated as to the image suggested by the word "cradle," 29 recalled the baby; 5 the mamma; 4 the motion of rocking, etc.; 3 the crying of the baby; 2 the sleep of the baby; 10 abstract ideas: innocence, maternal affection, tenderness, purity, the happiest period of life, maternal duties, the greater joy of woman, etc. Altogether, we may say that girls have less unity, boys less precision in their imaginative productions. Like Giuffrida-Ruggeri, Vitali sees nothing in the distinction between "reproductive" and "productive" imagination, since the former, the necessary antecedent of the latter, is only memory. According to Dr. Bagli, the folklorist, whom Vitali cites, the people of the Romagna, in general, as their popular literature proves, have never soared very

[1] La psicologia dell' immaginazione nella storia della filosofia. Roma, 1898.
[2] I Romagnoli. Forlì, 1896, pp. 116.
[3] Le Romagnole. Torino, 1898, pp. 126.

high on the wings of fancy, although so little of their work has been printed that one may be misjudging their ability in this direction. In the faithful imitation of the classics, the older, more naïve element of the folk-imagination has been swamped. Artistic production, too, has fallen into equal impotence—almost all the great painters of the Romagna have been, more or less, imitators. The people of the Romagna are executors of a very exact, patient, minute, subtle sort, but lack, in general, artistic inspiration, the "*scatto artistico*." Even ceramic art (Faenza is in the Romagna) is with them imitation, not invention. Music is worse off still. There is room for a good book on imagination, association, imitation, as revealed to us in this part of the Italian peninsula.

Inhibition. Professor Ruggero Oddi, of the Physiological Institute in the University of Genoa, discusses "Inhibition from the Physio-Pathological, Psychological and Social Point of View."[1] The preface is dated September, 1897, hence Colozza's[2] study of inhibition from the side of pedagogy, is not referred to, although each section of the book is provided with an ample bibliography. Oddi's general position is somewhat like that of Mercier, whom he quotes approvingly: Every thing in the organic, as well as in the inorganic world, is the result of a continuous, incessant struggle of antagonistic forces. The animal organism and the nervous system are not removed from the sphere of action of this law,—the struggle only becomes more intense, varied and complex by reason of the greater intensity, variety and complexity which characterize its life, its mode of being and appearing. The struggle of dynamogeny and inhibition, the contest of the force seeking to free and the force seeking to control or to prevent, make up the nervous life of man, no less than they do the life of the universe. Equilibrium of these forces produces inertia. Inhibition, according to Oddi, is, like dynamogeny, "a fundamental function of the nervous system, one of the antagonistic elements in the great struggle for life, a manifestation of protoplasmic irritability, of the excitability of the nervous element." The pathological side of the phenomena of inhibition is seen in such augmentations or diminutions of the powers of inhibition as result in a disturbance of the struggle of action and inaction, which is not transitory merely as such alternations normally are, but more or less permanent. In education and civilization progress has been by the transforming power of inhibition—from the child to the adult, from the savage to the man of culture, man has trodden the path of inhibition, and criminals and other social monstrosities are the failures that have accumulated by the road-side. Education thus "consists of a series of inhibitory acts tending to modify and repress the instinctive impulses of animal nature, and to habituate the nervous centers and nerve paths to preventing the passage of those stimuli promotive of harmful manifestations of anti-social instincts, just as we are wont to intercept the path of all that may result to the disadvantage of the individual." Where this development is not possible because of congenital atrophy or the arrest of development in certain parts of the nervous system, and such cases are still very numerous, we get the "born criminal," whom education can only transform from a brutal criminal into a refined and elegant one. Crime and its consorts can only be abolished by the slow growth of social well-being, material and moral prosperity, the satisfaction of physiological needs, the gradual disappearance of all inter-social hates. The social inheritance of inhibition will ultimately prevent rather

[1] L'inibizione dal punto di vista fisio-patologico, psicologico e sociale. Torino, 1898. VIII, 166 pp.
[2] Del potere di inibizione. Nota di pedagogia. Torino, 1897, pp, 128.

than suppress the criminal. As to inhibition itself we shall know its nature *per se* only when we discover the real nature of nerve elements. Colozza's book on "Inhibition," treated from the socio-pedagogical standpoint, should be read in connection with his earlier work on "Play,"[1] to which it is a pendant.

Premeditation. According to Dr. Jacopo Finzi[2] premeditation is not a special or characteristic sign of any species of murder, as is often thought, and it is self-evident that a premeditated crime is not, *per se*, more dangerous than an unpremeditated one. The distinction between the two is a matter of psychology, not of penology. While born-criminals are especially given to premeditation, it is not uncommon in occasional criminals, lunatics, epileptics, etc. An earlier writer on the same subject, Bernardino Alimena[3] had taken the view that the murderer who acts with premeditation is a particularly dangerous criminal, because premeditation is "the sign of an irreducible nature." Alimena considered that premeditation was, *per se*, a proof of the refractory character of the offender, in so far as reflexion is concerned. Certain mental affections, hypnotism, drunkenness, etc., are of great interest by reason of their influence upon premeditation.

Punishment. In his article "Considérations sur l'inefficacité de la peine chez les criminels vrais,"[4] Dr. Cesare Agostini, Professor of Criminal Anthropology at the University of Perugia, while not agreeing with the letter of Holtzendorff's declaration that "penal systems are bankrupt," comes to the conclusion that punishment, as we have it to-day is not efficacious as a represser of crime, as a protector of society—for real criminals are recidivists by nature and their anti-social instincts are not abolished but often encouraged by fixed terms of imprisonment. With occasional criminals and criminals by passion, such punishments as are now inflicted may sometimes secure amendment in the individuals through the feelings of shame and chagrin which they arouse, but this advantage is very little when compared with the depravity, degeneration and deprival of profitable and useful employment of undoubted energies and abilities which prison-life so often entails. In fact, normal individuals, who really do not need it, their own conscience serving them as corrective, are the only ones to whom punishment would be of use. Dr. Agostini is a partisan of the school of Lombroso and Ferri, and would settle the matter by perpetual isolation of the criminal in penitentiary colonies, where his labor would do some good to the community whose social and moral development made necessary his ostracism for life. Life treatment of this sort, and not fixed periods of imprisonment, is the only safeguard society can employ, short of the elimination of all true criminals by death. But Dr. Agostini, like the rest of the modern positive school, sees too much that is fixed and typical in the criminal and magnifies the hereditary factor in crime more than the evidence justifies. He sees too often the born-criminal, and the "physical basis" of crime, still believes in the "criminal brain," and is hopelessly convinced that "for every one who obeys instinctively a criminal impulse, punishment is a means of intimidation eminently useless."

Soliloquy. Dr. A. Raggi[5] has studied at the asylum in Pavia the soliloquy of 270 male and 210 female lunatics, with considerable detail

---

[1] Il giuoco nella psicologia e nella pedagogia. Torino, 1895, pp. 282.
[2] Il valore psicologica della premeditazione. [Estr. d. *Scuola Positiva*]. Firenze, 1897, pp. 11.
[3] La premeditazione in rapporto alla psicologia, al diritto, alla legislazione comparata. Con diagrammi. Torino, 1888, pp. XV, 286.
[4] Rev. de Psychol. clin. et thérap., Vol. III (1899), pp. 72–78.
[5] Osservazioni e considerazioni cliniche sul soliloquio dei pazzi. Il Manicomio moderno, Vol. XIV (1898), pp. 399–423.

as to condition, time, circumstance, stimuli, etc. Aside from the clinical data, the following, among other facts, are brought out by the investigation:

1. Soliloquy, while much more common in female, is very frequent with male lunatics.

2. Soliloquy occurs both by night and by day; its absence by night is very common, its absence by day much less so.

3. Soliloquy during sleep does not seem to be more common in lunatics than in sane individuals, rather rarer in fact.

In general, the soliloquy of lunatics has essentially the same significance as their ordinary language, but it needs always to be given more attention, for it possesses characters more evident and escapes all presumption of artifice or simulation.

Collective Psychology. French writers, Tarde and Le Bon especially, have been charged with borrowing not a few ideas and suggestions from the Italian psycho-criminologists, in particular from Sighele, whose "Criminal Couple"[1] saw its second edition in 1897. Here the phenomenon of criminal association, with its unique factor of suggestion, is seen in its simplicity, if that is at all possible, and all the facts of active and passive co-operation in criminality *à deux*, double suicides, double lunacies, love-murders, infanticides, etc., are touched upon, including the interesting and important folk-idea of the *succubi* and the demon-possession of the dark ages in Europe and elsewhere. The author holds, with Morselli, Ferri and others, that suicide and homicide follow contrary laws of development, and that, in love, suicide came first, then homicide, for which view there is not a little evidence to be gained from the study of primitive peoples, with whom love and its woes are much more common than most of us have thought.

That the "crowd," so much be-written of late years, by the writers of the Italian and French schools, Sighele, Tarde, LeBon, and others, is not so black as it has been painted may be read in Pasquale Rossi's "Mind of the Crowd,"[2] who exploits some of its virtues. Not infrequently crowds display altruistic and anti-criminal feelings, impulses, etc., and their pacific labors are by no means uncommon. However, the evidence is hardly enough to enable us as yet to scout the old saying: *Senatores boni viri, senatus mala bestia.*

Over against the crowd we may set the vagabond about whom quite a respectable mass of literature is growing up, as witness the essay of Cavaglieri and Florian, and the article of Donati.[3] The latter describes, with some detail, a "vagabond mystic;"[4] a fellow, who, in the early Christian days, or even in the Middle Ages, would have been a sort of saint, but is now classed among the degenerates, with weak moral sense, exaggerated mysticism, and ambulatory delirium.

BOOK NOTES.

G. S. H.

Die Wanderungen der Tiere, von WILLIAM MARSHALL. Seele and Co., Leipzig, 1897. pp. 24.

This is an interesting lecture describing very briefly the migratory habits and range of many species of birds and animals.

[1] La coppia criminale. Studio di psicologia morbosa. Torino, 1897, XVI, 216 pp.
[2] L'animo della folla (Appunti di psicologia collettiva). Cosenza, 1898, XIII, 286 pp.
[3] I vagabondi. Torino, 1897.
[4] Un caso di vagabondaggio mistico. Riv. Sperim. di Fren. Vol. XXIII (1897), pp. 160–173.

Die intellektuellen Eigenschaften (*Geist und Seele*) *der Pferde*, von F. A. ZURN. Schickhardt und Ebner, Stuttgart, 1899. pp. 55.

This is the eighth in a series of hippological treatises and considers many topics from skull capacity to the horse's power of observation, memory, judgment, knowledge of place, tone and color, fright, friendliness, or spite towards certain men or animals, play, pride, grief, deceit, revenge, imitation, temperament, etc. The author has evidently great personal familiarity with the horse and has read much literature upon the subject.

Insects: Their Structure and Life, by GEORGE H. CARPENTER. J. M. Dent and Co., London, 1899. pp. 404.

This is an admirable book copiously illustrated with nearly two hundred cuts and with a voluminous and well selected literature at the end. It first describes the structure and form of insects, then their life history, classification, orders, their surroundings, and their pedigree. The author is an expert entomologist of King's College, London.

Animal Behavior, by CHARLES O. WHITMAN. Woods Holl Biological Lectures, 1898. Ginn and Co., Boston, Mass., 1899. pp. 285–338.

The author is Head Professor of Biology at the University of Chicago, Editor of the Journal of Morphology, and Director of the Biological Laboratory at Woods Holl. In this pamphlet he has described the behavior of clepsine and the necturas under various stimuli designed to test their psychic activities. These are made with the author's usual care and pains and are valuable records, but more interesting to psychologists are the last twenty-five pages in which he characterizes the theories of instinct, and defends the view that pure instinct cannot be accounted for on Lamarckian principles, that the primary roots of instinct reach back to the nature of protoplasm and run parallel with organogeny, that instinct always precedes intelligence and is never lapsed mind. Psychologists never had so warm a welcome for biologists who enter this field as now.

Physiologie des Gefühls, von Z. OPPENHEIMER. C. Winter, Heidelberg, 1899. pp. 196.

This is a very important work by a very competent author who discusses first of all the free nerve endings, their path to the spinal cord, their influence under strong stimulation and the effect of weak stimulation which the author relates to feeling, the causes of satiety, appetite, hunger and thirst, the feeling center in the brain, and the likeness and contrast between pleasure and pain.

Das sexuelle Elend (*der oberen Stände*), von HEINZ STARKENBURG. W. Friedrich, Leipzig. pp. 139.

This is a sociological study largely based on statistics, showing in various lands a great increase of sexual crimes, with theories for cause and cure.

Geschlecht und Kunst, von GUSTAV NAUMANN. H. Haessel, Leipzig, 1899. pp. 193.

The relations between instinct and intellect, the development of the sexes, art and ethics, the genesis of the artistic, are treated in an interesting but popular way in order to lead up to the concluding chapters, one on Aphrodite and Athene, and the other on Dionysos and Apollo. The whole is intended as a prolegomena to a not yet written physiological æsthetics.

Schönheit und Liebe, von JOSEF SCHENK. F. W. Ellmenreich, Meran, 1899. pp. 81.

The author here grounds a new branch of æsthetics. After an introductory section, we are told in poetry the nature of beauty and of love, and after a longer prose chapter more poetry, and then again prose follows. The author moves, however, in a realm of very abstract definition and can hardly be said to have added to our knowledge of his theme.

Der Geschlechtstrieb. Die Idealisierung. Die Liebe. Von ANNA SERGEIEFF. W. Friedrich, Leipzig. pp. 98.

This well meaning lady would idealize love, in fact ideality and love are inseparable from each other, and this leads her to the conclusion that love is not chiefly an affair of youth but of mature years and even of old age.

"*Genesis*" *Das Gesetz der Zeugung*, von G. HERMAN. 1 Bd. Sexualismus und Generation. A. Strauch, Leipzig, 1899. pp. 143.

This is the first volume of a comprehensive and very speculative work upon the subject, though based on a wide reading in the biological field. The chief subjects treated are—polarity and its relation to sex; the nature of living substance; embryology; heredity; sexual selection; painless birth; and education of parenthood.

Die Wirkungen des Geistes und der Geister im Nachapostolischen Zeitalter bis auf Irenäus, von HEINRICH WEINEL. J. C. B. Mohr. Freiburg, Leipzig, und Tübingen, 1899. pp. 234.

In this typically German monograph, we have a very interesting and thorough presentation of the prevalent belief of early Christendom in spirits, good and bad, the effect of Christianity in weakening the power of evil spirits, an account of their modes of activity in causing glossolalia, ecstatic, and revelationary utterances, working miracles, causing cramps, sometimes in prompting or dissuading from great actions, the hearing, seeing and knowing of spirits and their effect in the field of smell, taste and touch, and the effect of baptism, anointment, prayer, asceticism, and suggestion upon pneumatic states.

Human Nature: Its Principles and the Principles of Physiognomy, by PHYSICIST. Parts 1 and 2. J. and A. Churchill, London, 1899. pp. 128, 175.

This anonymous work attempts to deduce human nature from the general physical, chemical and biological principles in order in the second volume to give a basis for the new classification of characters and to explain certain cardinal principles of physiognomy.

Brain, in Relation to Mind, by J. SANDERSON CHRISTISON. Chicago, 1899. pp. 143.

After hastily glancing over the new views concerning brain cells and their relations, and the theory of sensory and motor centers, the author proceeds to summarize current views concerning location of mind and to point out the relations of form and size to it, and to characterize normal mind. The writer's mind is suggestive and schematic, and his work although fragmentary is rather interesting reading.

La Doctrine de Spinoza. Par ÉMILE FERRIÈRE. Paris, F. Alcan. pp. 357.

This exposition and commentary of Spinozism in the light of modern science by this voluminous and able author is an attempt to state and disprove the entire geometric apparatus. Happily at the end of every

chapter is a synoptic résumé of its content. A comparison of stoicism with Spinozism which runs through the work is as interesting as it is unique.

The Revelation of Jesus. By GEORGE H. GILBERT. New York, The Macmillan Co., 1899. pp. 375.

This is a study of the primary sources of Christianity by a professor in the Chicago Theological Seminary, already widely and favorably known for his "Students' Life of Jesus and of St. Paul." Only Wendt had attempted so comprehensive a scheme before, and to make the revelation of Jesus historical was a distinct step in advance. An alternative title of the book might be The Conception and Development of the Kingdom of Heaven.

The Ritschlian Theology. By ALFRED E. GARVIE. Edinburgh, T. and T. Clark, 1899. pp. 400. Imported by Charles Scribner's Sons, New York.

At last we have a comprehensive work, critical and constructive, both an exposition and an estimate, as the title has it, of Ritschl and his school. Although attention is focused upon the few distinctive features which characterize it. Kaftan, Harnack and Herrmann are the only members of his school who are treated. They are allowed to speak for themselves, but the author is, on the whole, more critical than expositional. The doctrines chiefly treated are those of the church, sin, salvation, the kingdom of God, the nature of revelation, and the personal work of Jesus.

Das Schöpfungsproblem, von WILHELM WAAGEN. Münster, 1899. pp. 36.

We have here a very interesting attempt to epitomize current scientific views of cosmogony and to bring them into harmony with the record of the Old Testament. Much has to be forced and is artificial, but one cannot close this pamphlet without realizing that science and the Bible are after all not so very much opposed to each other.

NOTES AND NEWS.

NOTES.

The Thirteenth International Medical Congress.

The thirteenth International Congress of Medicine will be held at Paris, 2–9 August, 1900. The president is M. Lannelongue, rue François 3; the general secretary, M. Chauffard, rue Saint-Guillaume 21; and the general treasurer, M. Duflocq, rue Miromesnil 64, Paris. The Congress will be divided into five sections: biological sciences, medical sciences, surgical sciences, obstetrics and gynæcology, public medicine,—the first two offering features of special interest to psychologists. Information concerning conditions of membership, presentation of papers, etc., may be obtained from Dr. H. B. Jacobs, secretary of the American National Committee, 3 West Franklin Street, Baltimore, Md.

A New Method in the Study of Optical Illusions.

We have received, too late for review, an important paper by Dr. H. Stadelmann of Wuerzburg, which presents a new method for the classification of optical illusions. It will be remembered that Witasek (*Zeits. f. Psych.*, xix, 81) divides all current theories of optical illusion into two great groups,—perception theories and judgment theories. According to the former, we 'see' wrongly; according to the latter we see rightly, but judge incorrectly as to what we have perceived. Dr. Stadelmann puts his subjects in the somnambulistic state, and inhibits by suggestion the influence of the *Trugmotive* in a given illusion-figure: *e. g.*, the oblique lines in the Mueller-Lyer parallels. If the illusion is perceptive, he argues, this removal of the *Trugmotive* will leave the illusion intact when the subject is confronted with the figure in the waking state; if the illusion is, on the other hand, a matter of associated ideas or of judgment, then the inhibitory suggestion will kill the illusion. He finds that the illusion persists, after as before; and so concludes (with Witasek) that the perception theories are preferable to such interpretations as that offered by Lipps. The paper appears in the *Festschrift der phys.-med. Gesellschaft*, Wuerzburg, 1899.

The Need of another Psychological Journal.

It would appear at first sight, that the American public is well enough supplied with psychological magazines. Besides the *American Journal of Psychology*, a quarterly, and the *Psychological Review*, a bi-monthly journal, we have *Science*, a weekly devoted to the interests of science at large, and containing a fair proportion of psychological matter, and various philosophical magazines, all opening their pages more or less readily to articles of psychological tenor. Nevertheless, I venture to think that there is room for a psychological journal of a type different from any and all of these: a journal which shall approximate, as does, *e. g.*, the *Open Court*, more to the newspaper form, and which shall serve, somewhat as the *Intermédiaire* of M. Binet was intended to do, as a means of communication between students of

psychology, amateurs interested in psychological problems, and makers of psychological instruments. The contents of such a journal would consist, quite largely, of Discussions, the replies and counter-replies to criticisms,—the Corrections and Explanations,—that are necessitated by hasty reviewing or by honest misunderstanding, and that now occupy too conspicuous a place in pages that were better filled by constructive articles. The 'preliminary notice' might also be banished from the more serious magazines to the columns of the new journal; there might be interchange of question and answer between those who are less and more favorably situated with regard to library facilities; new apparatus, wherever described, might be redescribed and figured; European appreciations of American work might be published more quickly and less formally than is now possible; the barriers separating school from school, and laboratory from laboratory, might be, at least to some extent, broken down, and a common psychological atmosphere breathed by all workers in the science. Many a scientific controversy would dissolve into nothingness, could it be thoroughly threshed out by free and informal discussion; and many a dispute is perpetuated by the present conditions of publication.

I believe, then, that there is a place for a monthly paper or journal, of the kind outlined, and that it would be well worth the while of some one or more of our younger psychologists, not as yet hampered by other editorial duties, to undertake it. Advertisements ought to go far towards making such a journal self-supporting from the outset.

E. B. T.

NEWS.

Miss L. J. Martin has been appointed acting assistant professor of psychology at Stanford University.

An International Congress of Ethnology will be held at Paris, August 26 to September 1. One of the seven sections will be devoted to ethnographical psychology.

The eighth annual meeting of the American Psychological Association was held at New Haven, Dec. 27-29. The plan of meeting in two sections (an experimental and a philosophical), tried for the first time at this meeting, worked satisfactorily, though many members would have been glad to have been present in both sections at the same time. The feeling was general that time should not be given to sectional meetings to the detriment of the general meetings of the Association; and there seemed little desire to take any action that might lead to an actual division of the Association.

Besides going through the extended programme of papers, the following business was transacted. The officers were elected: President, Prof. Joseph Jastrow; members of the Council for three years, Prof. W. L. Bryan and Prof. George T. Ladd. Prof. Livingston Farrand remains Secretary and Treasurer, having been elected for three years. A large number of new members were also voted in. By an informal vote the Association expressed its willingness to meet in Chicago in 1901, should it at that time seem advisable to do so. Professors Bryan and Lindley, of the University of Indiana, were voted fifty dollars from the funds of the Association for the furtherance of their investigations upon the interesting mathematical prodigy whose skill they had demonstrated before the Association. The customary acknowledgments, also, were voted to Yale University and the members of its philosophical department—the hosts of the Association on this occasion.

The address of the outgoing President, Professor Dewey, will be published in the *Psychological Review* for March.

We learn from *Science* that the chair of Psychology at Columbia University has been endowed by Mr. J. D. Rockefeller with the sum of $100,000.

The Psychological Laboratory of Columbia University has recently undergone extension; it now consists of a series of 19 rooms,—a number reached heretofore only by Professor Wundt's Institute at Leipzig.

In *Nature* of Jan. 4 appears a protest by Professor Baldwin against the report of the Committee of the Royal Society Catalogue of Scientific Literature, in which the recommendation is made that psychology be classed under physiology, that the schedule submitted by Mr. G. F. Stout be cut up, and that fractions of it be inserted where place can be found for them under physiological headings. We are glad to endorse to the full the protest thus made against a suggestion which is both unwise and unjust.

Erratum: In foot note 1, page 191, for "Published in 1852 in Cincinnati" read "Published in London 1844." It may also be added that though the book in question (Vestiges of the Natural History of Creation) went through many editions anonymously it is now known to have been the work of Robert Chambers, publisher and litterateur, of Edinburgh.

BOOKS RECEIVED.

CHRISTISON, J. SANDERSON. Brain in relation to mind. Published by the Author, Chicago, 1899. pp. 143. Price, $1.25.

——— ———. Crime and criminals. Published by the Author, Chicago, 1899. pp. 177. Price, $1.25.

LE DANTEC, FELIX. Lamarckiens et Darwiniens, discussion de quelques théories sur la formation des espèces. Félix Alcan, Paris, 1899. pp. 192. Price, Fcs. 2.50.

DESCARTES, RENÉ. Discourse on method. Veitch's Translation (*Religion of Science Library*). Open Court Pub. Co., Chicago, 1899. pp. 87. Price, 25 cts.

DURAND, J. P. Nouvelles recherches sur l'esthétique et la morale. Félix Alcan, Paris, 1900. pp. 275. Price, Fcs. 5.

FÉRÉ, CH. L'instinct sexuel, évolution et dissolution. Félix Alcan, Paris, 1899. pp. 346. Price, Fcs. 4.

FERRIÈRE, EMILE. La doctrine de Spinoza exposée et commentée à la lumière des faits scientifiques. Félix Alcan, Paris, 1899. pp. 357. Price, Fcs. 3.50.

FULLERTON, GEORGE STUART. On Spinozistic immortality. (Publications of the University of Pennsylvania, Series in Philosophy, No. 3.) Ginn & Co., Boston, 1899. pp. 154.

GARVIE, ALFRED E. The Ritschlian Theology, critical and constructive. An exposition and an estimate. Imported by Charles Scribner's Sons, N. Y., (T. & T. Clark, Edinburgh,) 1899. pp. 400. Price, $3.00—net.

Human Nature, Its principles and the principles of physiognomy. By Physicist. J. and A. Churchill, London, Part I, 1897. pp. 128. Paper, 2 shillings; Part II, 1899. pp. 175. Price, 2s. 6d.

Jahresbericht ueber die Leistungen und Fortschritte auf dem Gebiete der Neurologie u. Psychiatrie. Jahrgang 2, 1898. S. Karger, Berlin, 1899. pp. 1406. Price, 32 marks.

JANES, EMILY (Editor). The Englishwoman's year book and directory, 1900. Adam & Charles Black, London, 1900. pp. 340.

JOHNSTON, CHARLES. The memory of past births. The Metaphysical Publishing Co., N. Y., 1899. pp. 50. Price, 25 cents.

LOOMIS, ERNEST. Seven essays on the subject of force-massing methods. Showing how to use occult forces, etc., in all business and art. Ernest Loomis, Chicago, 1899. pp. 134 + 22. Price, $1.25.

NAVILLE, ERNEST. Les philosophies négatives. Félix Alcan, Paris, 1900. pp. 263. Price, Fcs. 5.

OPPENHEIM, H. Nervenleiden und Erzichung. S. Karger, Berlin, 1899. pp. 56. Price, 1.20 marks.

PETZOLDT, JOSEPH. Einführung in die Philosophie der reinen Erfahrung. Erster Band. Die Bestimmtheit der Seele. B. G. Teubner, Leipzig, 1900. pp. 356. Price, 8 marks.

RIBOT, TH. The evolution of general ideas. Trans. by Frances A. Welby. Open Court Pub. Co., Chicago, 1899. pp. 231. Price, $1.25.

ROWE, STUART H. The physical nature of the child and how to study it. The Macmillan Co., N. Y., 1899. pp. 207. Price, $1.00.

STARBUCK, EDWIN DILLER. The psychology of religion. An empirical study of the growth of religious consciousness. With a preface by William James. Contemporary science series. Walter Scott, Limited, London, 1899. pp. 423. Price, 6 shillings.

WINDELBAND, W. History of ancient philosophy. Authorized translation by Herbert Ernest Cushman. From the second German edition. Charles Scribner's Sons, N. Y., 1899. pp. 393. Price, $2.00.

WOOD, HENRY. The political economy of natural law. Lee & Shepard, Boston, 1899. pp. 305. Price, in paper, 50 cts.

WOOD, HENRY. Ideal suggestion through mental photography. Lee & Shepard, Boston, 1899. pp. 163. Price, in paper, 50 cts.